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RATES OF SEDIMENT PRODUCTION IN MIDWESTERN UNITED STATES

By

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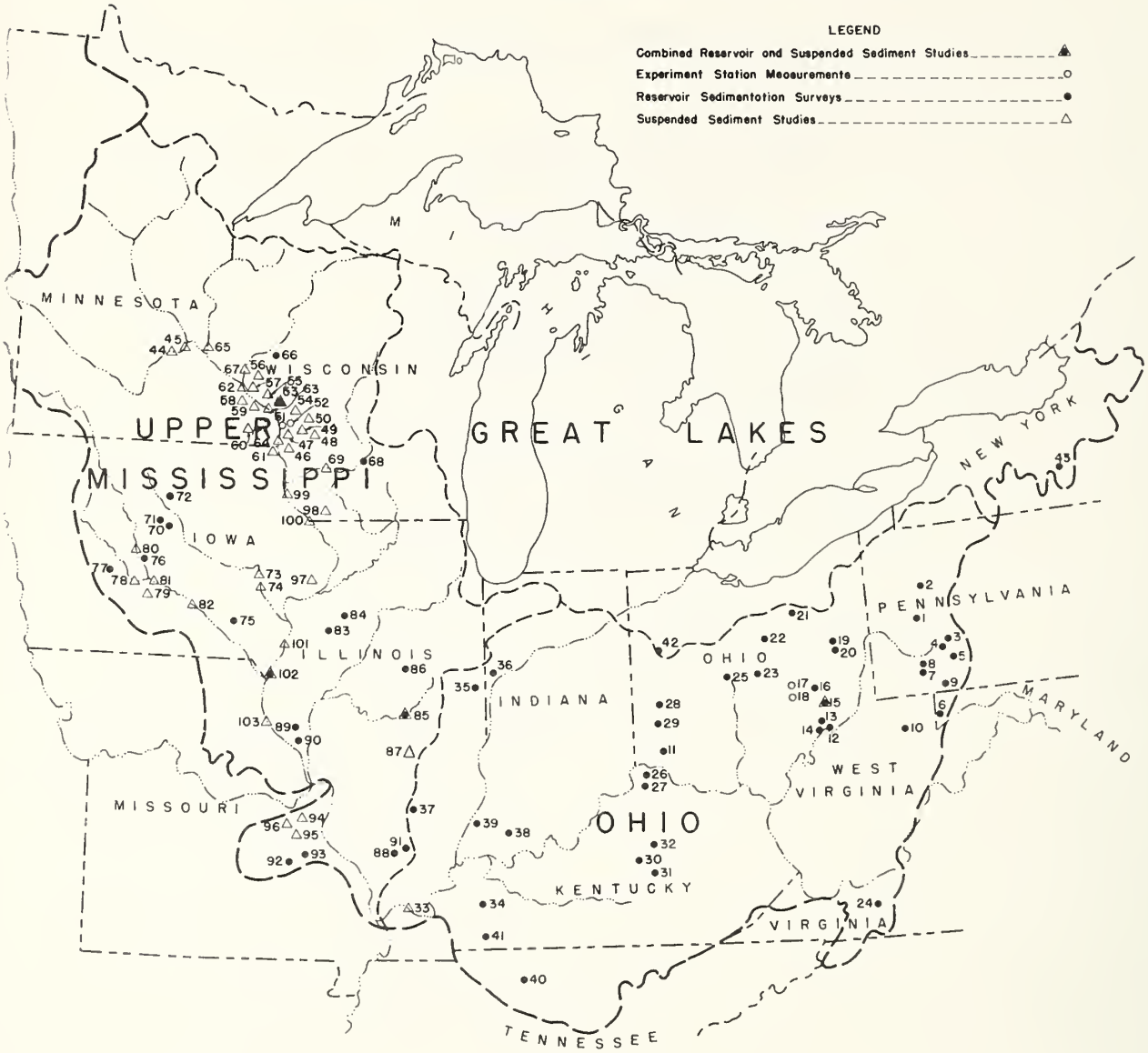
CONTENTS

		Pages
A.	INTRODUCTION	1 - 2
B.	ACKNOWLEDGEMENTS	2 - 3
C.	UNITS AND CONVERSIONS USED IN TABLES 3 AND 4	3 - 7
D.	ACCURACY OF DATA	
	1. Suspended Sediment Records	8 - 11
	2. Reservoir Sedimentation Surveys	11 - 13
	3. Experiment Station Measurements	13
	4. Combined Reservoir and Suspended Sediment Studies	13 - 14
	5. Comparative Value of the Various Types of Measurement	14
E.	LONG-TERM RATES OF SEDIMENT PRODUCTION	
	1. Present Rates	14 - 16
	2. Prediction of Rates	16 - 18
F.	NOTES ON RECORDS USED IN TABLES 3 AND 4	19 - 36
G.	REFERENCES CITED	36 - 40

FIGURE I.

LOCATION OF SEDIMENT RECORDS



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A. INTRODUCTION

Sediment is a major problem in flood control in the Midwestern States. Although the concentrations of solid matter carried by streams in this region are not so high as in the West, still, because runoff is so much greater and because there are so many more facilities to be damaged by sediment in the densely populated Midwest, sediment causes large annual damages.

The sediment loads carried by Midwestern streams have or should have a very significant influence on the location, design, and maintenance of storage reservoirs for power, irrigation, flood control, water supply, silt control, and recreation. Deposition of coarse sediment on agricultural bottomlands causes serious loss of soil fertility. Many drainage enterprises in the Midwest are severely damaged each year or are costly to maintain because of silting of drainage ditches. Agricultural lands and some urban areas are being flooded more frequently because of channel filling. Some bottomlands are being rendered too swampy for cultivation. Large amounts of sediment are settling each year in the navigable channels of the Mississippi River and its tributaries, and must be removed by dredging.

Other types of sediment damage in this region include the killing of growing plants and lowering of the carrying capacity of pastures by deposition on the foliage, destruction of desirable species of fish and other wildlife, recreational losses because of turbidity and silting of beaches, bulking of flood flows, and deposition of sediment in houses, streets, machinery, and wells. In order to plan adequate measures for reducing these costly sediment damages, it is necessary to have reliable information on the sediment loads carried by streams in this region.

This publication summarizes available records for the Midwestern States (Upper Mississippi, Ohio and Great Lakes drainage basins) in a form similar to that previously used for the Southwestern States (4). An attempt has been made to compile, evaluate and translate into comparable units all of the data that are considered usable in estimating quantities of sediment carried by streams in this region.

The geographic locations of the records shown in Figure 1 are numbered to correspond with the numbers of the records given in Tables 3 and 4. The types of records used are summarized by drainage basins in Table 1.

The less reliable types of records have been eliminated from this study. Such records as exist, however, are widely scattered, often in

obscure publications or in unpublished files. A considerable number of the reservoir surveys used were made by the writer, most of them not previously published. Where published, the summary data are sometimes difficult to evaluate from lack of information on the manner of their collection.

TABLE 1 -- TYPES OF SEDIMENT RECORDS USED

Type of Record	Ohio River Basin	Great Lakes Basin	Upper Mississippi R. Basin	Total
Suspended Sediment Measurements	1	0	39	40
Reservoir Sedimentation Surveys	37	2	16	55
Experiment Station Measurements	2	0	2	4
Combined Reservoir and Suspended Sediment Studies	1	0	3	4
Total	41	2	60	103

From these basic data and consideration of the various factors affecting the sediment load of streams, estimates have been made of the probable long-term average annual rates of sediment production. Considering the nature of the records and the time available for this study, it is obvious that such estimates involve a large element of personal judgment. It was necessary to make various assumptions which cannot be rigorously tested at present. Because of the demonstrated practical need and frequent requests for such estimates, the writer has prepared this report. It must be emphasized, however, that a great deal of work remains to be done in the field of predicting rates of sediment production. Not enough information is yet available for accurate quantitative evaluation of many of the factors which are involved in this problem.

Section E-2 of this report outlines a method of estimating rates of sediment production, which, in the writer's opinion, will give a rough approximation, generally close enough for preliminary estimation and damage evaluation. In using this method the factors of land use, size of drainage area, mean annual runoff, soil type, length of slope, degree of slope, and type of crop rotation are employed. In cases in which the rate of sediment production must be known with greater accuracy, as in connection with the construction of an important reservoir, a detailed study, including the factors not evaluated in this study, should be made.

B. ACKNOWLEDGEMENTS

The writer is greatly indebted to the following agencies for making available to him suspended sediment load and reservoir sedimentation survey data which have not yet been published: District Offices, Corps of Engineers, Department of the Army, at St. Paul, Minn., Rock Island, Ill., St. Louis, Mo., Louisville, Ky., and

Huntington, W. Va.; District Offices, U. S. Geological Survey, at Madison, Wis., Iowa City, Ia., and St. Louis, Mo.; Iowa State Conservation Commission, Des Moines, Ia.; and the City Water Department, Columbus, Ohio. Many of the sediment load records received from these agencies had not been summarized or evaluated. The writer wishes to point out that the methods used in summarizing and evaluating these data are not necessarily those used or recommended by the agencies concerned. In addition, a large number of records were obtained from previously published sources too numerous to mention here. These are listed in Section G of this report. The writer is also indebted to Carl B. Brown, Sedimentation Specialist, Office of Research, Soil Conservation Service, Washington, D.C., for reviewing the manuscript of this report.

C. UNITS AND CONVERSIONS USED IN TABLES 3 AND 4

Column 3. - Drainage areas are taken from the best available sources. First preference has been given to the latest drainage area figures published in U. S. Geological Survey Water Supply Papers (35). Also used are figures from the Illinois State Water Survey Division (17), from the Ohio State Engineering Experiment Station (25), and from the various published reports on sedimentation studies. In the case of reservoirs, all drainage areas are exclusive of the lake area unless otherwise noted. For flood-control reservoirs with conservation pools, only the conservation pool area is excluded. The drainage area of any upstream reservoir with more than an estimated 50 percent trap efficiency is also excluded.

Column 4-8. - These figures are taken chiefly from census data, from unpublished data in Soil Conservation files, from the various reports on reservoir sedimentation surveys, and from personal inspection of many watersheds. In all cases an attempt was made to obtain the average land use during the period. In some cases, such as in Record 42, in which the reservoir was built some time before any appreciable amount of clearing or farming was done in the area, the average land use during the period was quite different from the present land use.

Column 10. - The number of decimal places indicates the accuracy with which the length of record is known. It is often practically impossible to establish exactly the date of beginning of storage and sedimentation in reservoirs. Available records for the older reservoirs usually give only the year of completion. If the beginning of the period of record is known only to the nearest year, then, even though the date of ending of the period is known exactly, the length of record can be given only to the nearest year.

Column 11. - The figure given in this column is based on a point system, which is an attempt to give proper weight to all of the factors that influence the reliability of the data. The basis of weighting was as follows:

1. Type of survey or measurement.

a. Combined reservoir survey and suspended load measurements, or experiment station measurements. 8 points

b. Detailed reservoir sedimentation survey. 7 points

c. Complete suspended sediment sampling with reliable sampler. 5 points

d. Fair or incomplete suspended sediment sampling or range or grid type reconnaissance reservoir sedimentation survey. 3 points

2. Specific weight measurement.

a. Samples taken for specific weight measurement. (This credit is automatically given in the case of suspended sediment and experiment station measurements which require no volume-weight conversion.) 2 points

b. No samples taken for specific weight measurement. 0 points

3. Divergence of annual runoff from mean.

a. Average annual runoff during period less than 5 percent above or below mean annual runoff. 3 points

b. Average annual runoff during period from 5 to 25 percent above or below mean annual runoff. 1 point

c. Average annual runoff during period over 25 percent above or below mean annual runoff. 0 points

4. Estimated proportion of sediment production measured.

a. Measured sediment within 5 percent of total estimated sediment production. 2 points

b. Measured sediment 5 to 25 percent above or below total estimated sediment production. 1 point

c. Measured sediment more than 25 percent above or below total estimated sediment production. 0 points

Column 12-13. - The average annual runoff during the period of sediment measurements and the mean annual runoff have been compiled from all available sources, preference being given to the latest figures published in U. S. Geological Survey Water Supply Papers (35). Since this part of the country has a relative abundance of gaging stations with long records, it was unnecessary to estimate runoff from rainfall records. In many cases a gaging station is located at the particular reservoir or sampling station where the sediment record was obtained. It was often more desirable, however, to use records of runoff per square mile from a gaging station a short distance away which had a longer record. This made possible a ready comparison of the annual runoff during the period with the mean annual runoff. Wherever possible, a gaging station with approximately the same size drainage area as at the point of sediment measurement was used, in order to eliminate the effect of size of drainage area on annual runoff per square mile. The data used, however, indicate that although the runoff per square mile from a given storm decreases as the drainage area becomes larger, the total annual runoff per square mile does not decrease noticeably with increasing size of drainage area.

The figures in these columns were usually computed by the equation:

$$R = 722.7 \ (Q \text{ mean})$$

where R = Annual runoff in acre-feet per square mile for the year in question.

Q mean = Mean discharge in second-feet per square mile for the year in question, as reported in U. S. Geological Survey Water Supply Papers.

722.7 = Coefficient 1.98 (to convert c.f.s. to acre-feet/day) x 365 (days per year).

Column 14. - This is the percentage by which the average annual runoff per square mile during the period of record (Column 12) is larger than (+) or smaller than (-) the mean annual runoff per square mile for the entire period for which runoff records are available. (Column 13).

Column 15. - This column applies only to reservoir sedimentation surveys. The specific weight has been estimated in most cases by comparison of the C/W (capacity-watershed area) ratio of the reservoir, character of deposits, extent and frequency of reservoir drawdown, and soil types found in the drainage area, with similar characteristics of reservoirs where average specific weight has been determined (39). Those figures which have numbers to the right of the decimal point are not estimated but are measured values from sediment sample analyses.

Column 16. - This column contains only records obtained from reservoir sedimentation surveys. The data include not only the volume of

sediment measured below spillway level, but also, where available and where caused by the reservoir, above-crest and up-valley deposits. The records also include in some cases material dredged from the reservoir. These values ordinarily do not include the sediment that passes through the reservoir and over the spillway or through outlets in the dam. These losses are taken into account in the estimates in Column 19. In some cases, however (Records 15, 53, 85, and 102), where measurements of suspended load or turbidity studies have been made in connection with the reservoir survey in order to determine the proportion of sediment passing through the reservoir, these measured values have been included in this column.

Column 17. - All values in this column for which there are no corresponding values in Column 15 or 16 were obtained from suspended sediment or experiment station measurements. In the case of suspended load measurements, they do not include bed load. Bed load is taken into account, however, in the estimates in Column 19. The values shown where corresponding figures are given in Column 16 were derived by the following equation:

$$T = 21.78\ S\ (V)$$

where T = Tons per square mile per year.

S = Specific weight, in pounds of dry solids per cubic foot of deposits in place.

V = Volume of deposits in acre-feet per square mile per year.

21.78 = Coefficient 43,560 (cubic feet per acre-foot)

÷ 2,000 (pounds per ton).

Column 18. - The figures in this column are based on consideration of the following factors:

1. In using reservoir sedimentation records, the relationship between the measured reservoir deposits, above and below crest, to the total sediment load, including sediment lost over the spillway or through outlets.

2. In using suspended sediment records, the relationship between the measured suspended load and the total sediment load, including bed load.

3. In using suspended sediment records, the relationship between results obtained with older type samplers and those obtained by applying a correction factor based on comparative field tests with the scientifically designed D-43 sampler (40).

The effect of abnormal runoff during the period of record is not considered in this column. It is, however,

considered in Column 19.

Column 19. - The estimates in this column are for the long-term average annual sediment load under the conditions of land use and river development that have prevailed during the period of record. They represent simply the writer's judgment based upon consideration of the following factors:

1. Abnormal runoff conditions during the period of record. (Column 12-14.)

2. Trap efficiency of reservoir, allowance for bed load, method of sampling, type of sampler, and method of computation. (Column 18.)

Land use changes and extent of watershed cover deterioration were not considered in making these estimates. The average land use during the period of record is given in Columns 4-8. These land use figures are used and discussed at length in Section E.

Column 20. - Estimated long-term sediment concentration in runoff was computed by the equation:

$$S_c = \frac{S_t}{1359\ (R)}$$

where

S_c = Estimated long-term sediment concentration in percent by weight

S_t = Estimated long-term annual sediment production per square mile, in tons (Column 19)

R = Mean annual runoff per square mile, in acre-feet (Column 13)

1359 = Weight on one acre-foot of sediment-free water, in tons.

The concentration as thus derived is: Weight of dry sediment ÷ weight of a volume of pure water equal to the volume of sediment-water runoff.

The preferred method of expressing sediment concentration for individual samples is: Weight of dry sediment ÷ total weight of sediment and water in sample. Up to 5 percent concentration, there is an insignificant difference between the two methods (43). The greatest long-term sediment concentration known to have been measured in this region was 4.82 percent on a 100 percent cultivated experimental watershed at LaCrosse, Wisconsin (Record 51) from 1934 to 1938.

D. ACCURACY OF DATA

1. Suspended Sediment Records

Many of the older suspended load sampling records were not used in this study because they were computed in a manner that gives a systematic error in the direction of underestimation. In the data collected by Dole and Stabler in 1906 and 1907 (27 and 34, pp. 78-93), samples were collected almost daily, but were combined in approximately equal proportions at intervals of about 10 days, more or less, and the composite samples were analyzed. The percent of sediment by weight in the sample and the average discharge for the corresponding period were then used to compute the average daily suspended load. In other cases, such as the suspended sediment samples collected by the City of Nashville from 1934 to 1943, the average discharge and average concentration for the entire month were used to compute the monthly sediment discharge. These methods are based on arithmetical averaging and fail to give proper weight to the larger loads carried during periods of higher discharge. Fortunately, because of the relative abundance of suspended sediment records in this region, it was not considered necessary to use these less reliable types of records in this study.

In sediment load studies, estimation of the amount of bed load transported is one of the greatest sources of error. A study has been made to estimate the bed load movement on Bay Creek (Record 90) and other nearby tributaries to The Sny, an old channel of the Mississippi River (unpublished material in Soil Conservation Service files). On the basis of sand and gravel deposits in the nearby Hadley Creek desilting basin and other deposits on The Sny bottomlands, it was estimated that the long-term annual bed load production of Bay Creek is 900 tons per square mile. This is 26 percent of the total estimated long-term annual sediment load. Bay Creek undoubtedly moves a relatively large bed load chiefly because of its high gradient and abundance of coarser sediment sizes available.

The St. Paul District, Corps of Engineers, Department of the Army, has estimated on the basis of laboratory studies (29) that the total sediment load of the Chippewa River at Durand, Wisconsin (Record 67) consists of 84 percent bed load and only 16 percent suspended load. This unusual situation is caused chiefly by the relative abundance of sand and scarcity of finer sediment sizes in this drainage area. The amount of bed load carried by other streams for which suspended load records were used has been estimated on the basis of the relative abundance of coarse sediment, the stream gradients, and evidence on rapidity of channel shifting.

Another very important source of error in suspended sediment studies is abnormal runoff during the period of record. It is possible to compensate approximately for this error, but the shorter the period of measurement, the more abnormal the runoff is likely to be, and the greater is the possibility of error from this factor. Although no records of less than one year's duration were used, most of the suspended sediment records in this region cover periods of

relatively few years.

It has been found for several streams that there is no consistent relationship between the daily runoff and the daily suspended sediment load. In several cases, however, there is a fairly well defined relationship between the monthly or annual runoff and the monthly or annual suspended load. Although no suspended load sampling stations have been maintained in this region for more than six or seven years at a time, preliminary data from Records 47-49 and others indicate that the annual rate of sediment production varies roughly with at least the square of the annual runoff. This relationship was used in correcting annual sediment production with abnormal runoff to the annual sediment production which would have taken place with normal runoff. It is recognized that the exponent varies considerably with different stations, but the square is probably close to the average for this region for annual rates of sediment production. Brown's studies (4) in the Southwest show comparable relationships. He found that annual suspended sediment load varies with annual runoff to the 1.52 power on the Colorado River at Grand Canyon, Arizona, and to the 2.43 power on the Green River at Green River, Utah. Straub, in his Missouri basin studies (26a, pp. 1084-1086) used an exponent of 2.16 for "long-time periods."

In regard to frequency of sampling, Love (21) has shown that a very large proportion of the total annual suspended load of many small streams is carried during a few days out of the year. For example, during 1938 on Coon Creek at Coon Valley, Wisconsin (Record 48), the load carried on 7 days was 88.2 percent of the total load for the year. The insufficient frequency of sampling of some small streams, such as that done on Hadley Creek, Illinois, from 1940 to 1945, make the records of doubtful value for total annual suspended load determination. Hence they were not used in this study. In this case the samples were taken at intervals of one week regardless of discharge, and consequently many periods of high discharge and high sediment load were missed. The same principle applies to larger streams although the proportions are not so pronounced.

It is well known that turbidity records expressed in parts per million may deviate considerably from the true suspended sediment concentration in parts per million (42). In Record 33, the turbidity readings are definitely on the low side. However, as the turbidity readings were used only for low flow periods, this error is relatively minor. An allowance was made for this factor in estimating the long-term rate of sediment production. In only one other case (Record 85) were turbidity records used. In this case they were used to estimate the amount of sediment lost over the spillway and through the outlets in the dam. Since this was a relatively small part of the total sediment production, however, the error from this source is probably small.

Experimental work on sediment samplers at the Iowa Institute of Hydraulic Research (36, 38, and 40), and subsequent field tests of the scientifically designed D-43 sampler by various agencies indicate that sediment concentrations obtained with some samplers, are high or low

when compared with the D-43 sampler. One type of Rock Island sampler, for example, gave results 42 percent higher than those of the D-43 sampler. In making estimates of long-term sediment production, all suspended sediment records were first converted to D-43 standards on the basis of results of the comparative tests thus far made (40). The accuracy of the suspended load record also depends on the method of sampling. The concentration of sediment at different points in the cross-section is known to vary markedly on some streams. In general, the coarser the sediment particles the greater is the variation. Therefore, a single point sample may show a concentration greatly different from the average of the cross-section. A single depth integrated sample will give a more accurate measurement, while several depth integrated or point integrated samples will give the most accurate measurement (37). The sampling records used for this study consisted chiefly of single point samples with an occasional "station factor" sample of 5 to 7 samples on most streams. In Record 33, every sampling consisted of from 12 to 30 samples.

Suspended load records were excluded from this study for any of the following reasons:

1. Record of less than one year's duration. Many suspended load records would have been of value in this study had they covered a slightly longer period. In this category fall the suspended load measurements made by the Buffalo District, Corps of Engineers, Department of the Army, from April to June 1944 on the Cuyahoga River at Cleveland and Independence, Ohio, which would have been particularly valuable in view of the scarcity of data in the Great Lakes drainage basin. In periods of less than one year the possible error caused by incomplete seasonal sampling of runoff becomes too large for the limits of accuracy adopted in this study.

2. Uncertain drainage area. For this reason the suspended load measurements at five stations on the Illinois River described by Stevens (26) were not used. Large amounts of water are diverted from Lake Michigan into the Illinois River through the Chicago Sanitary and Ship Canal, increasing the sediment-carrying capacity of the river and making it impossible to place sediment production rates on a per-square-mile basis.

3. Sediment traps of doubtful trap efficiency upstream particularly when the upstream trap has been in existence during only a part of the period of record. In some cases, such as in Record 90 however, an exception has been made. In this case the upstream trap, Pittsfield Reservoir, has been in existence during the entire period of record, and has a trap efficiency which can be estimated with reasonable accuracy.

In most cases the sediment load was plotted daily, using discharge records to fill in small gaps. The total load for the period of measurement was then planimetered.

In order of relative accuracy the suspended load records used in

this study may be classified into two groups. Group 1, the most accurate, includes Records 47, 48, 49, 64, 74, 78, 80, 81, and 90. These records are based on frequent sampling with reliable samplers and the records contain no gaps. Group 2, in which sampling was less frequent or was not carried on during the winter months, or in which the sampling characteristics of the sampler are not known exactly, includes Records 33, 44, 45, 46, 50, 54-63, 65, 67, 69, 73, 79, 82, 87, 94-101, and 103.

In contrast with the Southwest, where it appears that most existing suspended sediment records are biased on the low side, suspended sediment records in the Midwest appear to be both high and low.

2. Reservoir Sedimentation Surveys.

Probably the greatest source of error in using reservoir sedimentation survey data as an index of sediment production rates, arises in estimating the amount of sediment which is lost over the spillway or through outlets in the dam. In estimating the trap efficiency of reservoirs, curves previously published by Brown (3) were used, together with trap efficiencies computed for other reservoirs of various types by the writer (Records 15, 53, 85, and 102). In all cases the estimated average trap efficiency during the period of record, and not the original trap efficiency, was used. That part of the sediment trapped by a reservoir is usually of higher specific weight than the total sediment load would have been if it had all been trapped, because the finer, lighter material has passed over the spillway. However, since trap efficiency is computed by comparing the weight, not volume of sediment, no error is introduced from this cause.

In using reservoir survey records, an error may also result from converting measured volumes of sediment to tonnage on the basis of an estimated average specific weight. The estimated specific weights in Tables 3 and 4 should be within 10 pounds per cubic foot of the correct average. The percentage difference decreases with increasing weight. One acre-foot of sediment at 60 pounds per cubic foot weighs 20 percent more than one acre-foot at 50 pounds, while one acre-foot at 85 pounds weighs 13.3 percent more than one acre-foot at 75 pounds. In Records 28, 29, 53, 85, and 92, this is not a problem, as sediment samples were taken and the specific weight determined. The samples taken for Records 28 and 29 are unusually valuable, because information on the specific weight of sediment in such "dry" flood control reservoirs has been very scarce.

In using reservoir survey records, as in suspended sediment studies, abnormal runoff is a source of error. This was compensated for by the same method as was used in the case of suspended sediment studies. As the records obtained from reservoir sedimentation surveys, however, usually cover a considerable number of years, the departure from normal runoff is not great, and the possible error from this cause is consequently unimportant.

Tests have been made in 10 detailed reservoir surveys by the Soil Conservation Service for limits of error in capacity and sediment volume determination. Each of these surveys was made by both the

range and contour methods described by Eakin and Brown (10, pp. 153-168). The maximum difference obtained was less than 4 percent, and the average difference was less than 1 percent.

The accuracy of reservoir reconnaissance surveys has been statistically tested by comparison with detailed surveys of the same reservoirs. The test consisted of 50 samples in which many varieties of reconnaissance methods were used. The results indicated that a specialist in these surveys, using the more reliable methods of survey, such as a range or grid system, should be able to measure sediment volume within 10 percent in 80 percent of the reservoirs on which reconnaissance surveys are made, with a maximum error of not over 30 percent. Only data from these more reliable types of reconnaissance surveys were used in this study.

Reconnaissance surveys using only a number of random shots throughout a reservoir may have an error up to 75 percent. Records from such surveys, which are numerous, were not used in this study.

In addition, reservoir survey records were excluded from this study for any of the following reasons:

1. Record of less than one year's duration. In contrast to suspended load studies, very few reservoir surveys cover less than one year's period, and therefore few were excluded for this reason.

2. Less than 30 percent estimated trap efficiency. In reservoirs of low trap efficiencies, it is more difficult to estimate the trap efficiency accurately. In reservoirs of very low trap efficiency there may be a net scour rather than sediment deposition during periods of high discharge. For these reasons records such as that for Williams Reservoir on the East Fork of White River in Lawrence County, Indiana, although valuable for some purposes, have little value as indices of sediment production rates.

3. Uncertain drainage area. The survey of Buckeye Lake in Ohio, for example, with its 107-year period, would have made a very good record, except for the fact that at various times during its history water has been diverted into it from the South Fork of Licking River. With such a variable drainage area, it is impossible to place the rate of sediment production on a per-square-mile basis.

4. Sediment traps of doubtful trap efficiency upstream, particularly when the upstream trap has been in existence during only a part of the period of record. In this connection it may be well to point out that although Upper Pine Lake (Record 71) now constitutes a sediment trap above Pine Lake (Record 70), the record on Pine Lake was taken before the construction of Upper Pine Lake, and therefore was not affected by it.

5. Any important amount of dredging of the reservoir during the period. If, however, the amount of dredged material was carefully measured in connection with the survey, as was done in the case of Record 53, the record was not excluded.

3. Experiment Station Measurements.

Experiment station records are usually obtained by catching the sediment and water from a small watershed in a sediment-collecting box, allowing the sediment to settle out, and weighing samples of it. Any water which overflows the box is sampled and the amount of sediment not caught in the box can then be computed.

Abnormal runoff can cause the same possible error in this type of measurement as in the preceding two, particularly if the period of record is short and the variation from normal runoff is pronounced.

An error may be introduced by the type of suspended sediment sampler used but, since a relatively small amount of sediment is not caught in the box, and since sampling conditions are controlled, this error is considered insignificant.

This type of measurement is one of the most accurate. All bed load is trapped and measured. Sediment samples are weighed, eliminating the error introduced by estimating volume-weight conversions. There is no error from estimating sediment lost from the box, as this sediment is sampled in suspension.

4. Combined Reservoir and Suspended Sediment Studies.

In this type of record the sediment caught in a reservoir during a given period is measured and at the same time a suspended sediment station just below the dam measures any sediment which is not trapped. Since all bed load is trapped and measured, there is no error from incorrect estimation of the amount of bed load. Also, since the finer sediment which passes over the spillway or through other outlets is sampled, there is no error from incorrect estimation of the trap efficiency of the reservoir.

Unless samples of the reservoir sediment are taken for specific weight measurement, an error may arise in estimating the specific weight of this sediment. This error, however, does not apply to that portion of the sediment load measured by sampling below the dam.

There may be an error in sampling the suspended sediment if the sampler used collects too little or too much sediment. The portion of the sediment load which passes through the reservoir and over the spillway, however, is usually very fine textured and uniformly distributed through the flow. Furthermore, only a relatively small proportion of the total load generally passes through the reservoir.

Finally, of course, there is the factor of abnormal runoff. Especially if the period covered by the reservoir sedimentation survey and that covered by the suspended sediment measurements are not iden-

FIGURE 2.

MEAN ANNUAL RUNOFF IN ACRE FEET PER SQUARE MILE

tical, there is a possibility of error. For instance, if runoff during the period covered by the reservoir survey is higher than normal, and during the period of suspended sediment measurements lower than normal, it may be difficult to arrive at a true value for the trap efficiency of the reservoir.

5. Comparative Value of the Various Types of Measurement.

It is clear that the most accurate type of measurement of rates of sediment production from larger watersheds is the combined reservoir survey and suspended sediment measurement. In this method the greatest weakness of suspended sediment studies is eliminated, since the bed load is measured; and the greatest weakness of reservoir surveys is overcome, since the sediment which is not trapped is sampled. This type of measurement, to achieve the highest possible degree of accuracy, should include sampling of the reservoir sediment for specific weight determination. For greatest accuracy also the periods covered by the reservoir survey and suspended sediment observations should be identical.

Experiment station measurements also rate very high, since they trap the bed material and sample any sediment that cannot be trapped. They are, however, limited to very small watersheds.

Reservoir sedimentation surveys alone rank third, and suspended sediment studies alone are considered the least reliable.

Under the rating system described in Section C, the rating for any particular record may vary from 3 to 15. Using this system, the average rating for the combined reservoir and suspended sediment studies used in this report is 13.0, for experiment station measurements 15.0, for reservoir sedimentation surveys 7.7, and for suspended sediment studies 7.0. It should be understood that these figures have no absolute value but are merely indications of the comparative reliability of the various records.

E. LONG-TERM RATES OF SEDIMENT PRODUCTION

1. Present Rates.

In the Midwestern States some of the major factors that influence rates of sediment production are land use, size of drainage area, and annual runoff. Land use changes which increase or decrease soil erosion cause considerable changes in rates of sediment production in the Midwest. Brown, Stall and DeTurk (6) have demonstrated this conclusively in the case of Lake Decatur, Illinois. The writer has also prepared data on a number of reservoirs in this region (7) and in the Southeast (8), which show a clear relationship between rates of sedimentation and land use.

Soil types, degree of slopes, length of slopes, and type of rotation are other important factors which influence rates of sediment production, as shown by the land damage studies recently made by the

Soil Conservation Service. These studies determined the rate of soil loss that could be expected in each Basic Resource Area in the country, as influenced by the above factors.

As the size of the drainage area increases, the rate of sediment production per square mile usually decreases. This is the result of several factors. Gradients become progressively flatter downstream, carrying power is consequently reduced, and large amounts of sediment are dropped on floodplains and in channels. The average slopes and topography generally become less steep as the watershed area increases, this being particularly true for those streams rising in mountainous areas. The chances that an intense storm will occur over the entire watershed become less and less as the watershed becomes larger. There is also more variation in the rate of sediment production in smaller watersheds, as pointed out by Brown (5), chiefly because land use varies more widely in smaller watersheds.

In some cases, however, the sediment load per square mile of drainage area may increase as the size of drainage area increases. The Mississippi River (Records 62-64 and 99-103) will serve as an example. From Wabasha, Minnesota (Record 62) to Keokuk, Iowa (Record 102), the estimated long-term annual rate of sediment production increases from 22 to 290 tons per square mile. This increase is due primarily to changes in land use, annual runoff, soils and topography. For the drainage area as a whole, the proportion of land in cultivation or idle rises from 30 to 40 percent between these two points, and the runoff per square mile also increases markedly (see Figure 2). Above Wabasha there are a great many lakes that intercept the sediment. Below that point there is a marked change in soils and topography as drainage from the driftless area begins to come into the Mississippi River. If all these factors remained constant as the drainage area increased, in all probability the rate of sediment production would decrease rather than increase.

In Figures 3 and 4 these first two factors, land use and size of drainage area, are plotted for the Ohio River and Great Lakes, and for the Upper Mississippi River drainage basins. In order to reduce the factor of annual runoff, they are plotted against long-term sediment concentration rather than rate of sediment production. Also, in order to eliminate the effect of soil type, degree of slope, length of slope, and type of rotation, each plotted point has been adjusted upward or downward. In making this adjustment, the long-term sediment concentration in runoff for each record has been multiplied by the reciprocal of the factor given in Table 2 for the Major Basic Resource Area or Areas in which the drainage area lies. In this way data from many Basic Resource Areas have been brought together on a uniform standard.

Median lines have been drawn for three land use categories: less than one-third, one-third to two-thirds, and over two-thirds, of the drainage area cultivated and idle. These lines show a trend toward lower sediment concentrations with increasing size of drainage area, if the land use remains the same. They do not show more spread in the smaller size drainage areas, because the land use is held constant. These two graphs have some similarity to one previously devel-

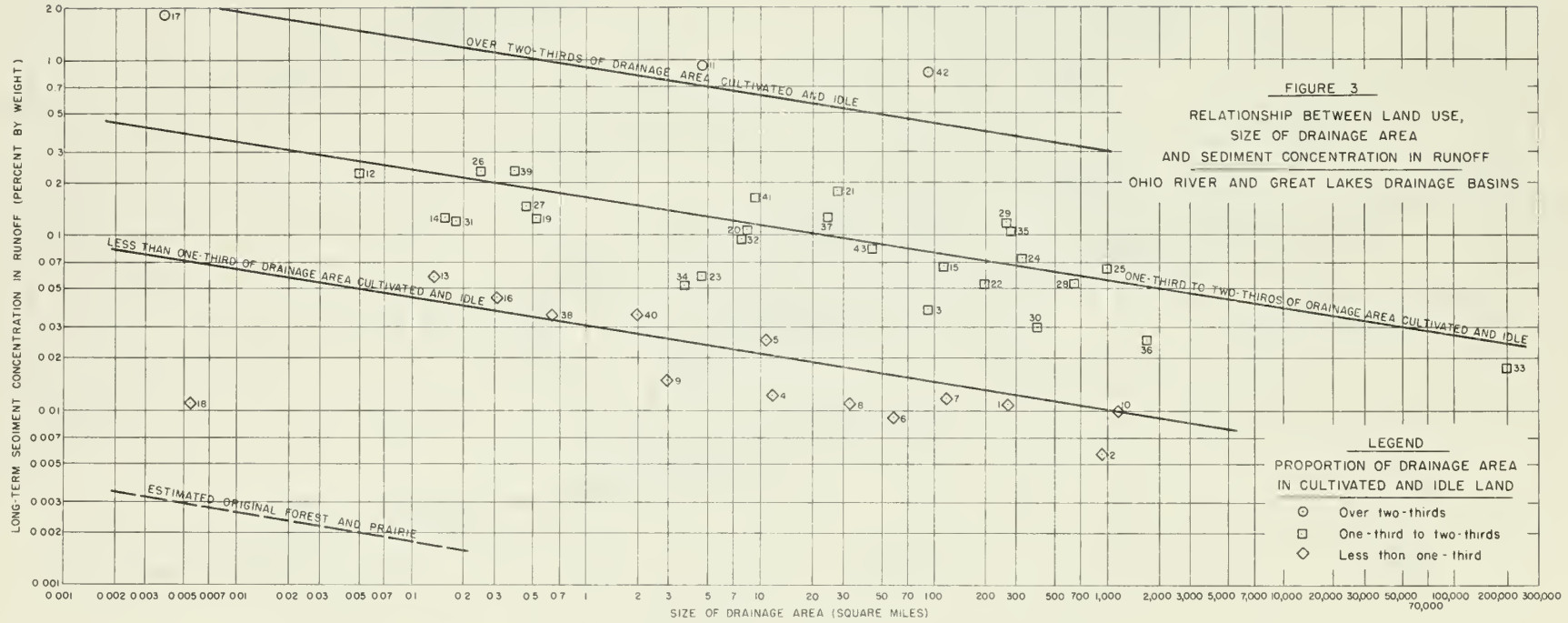


FIGURE 3

RELATIONSHIP BETWEEN LAND USE, SIZE OF DRAINAGE AREA AND SEDIMENT CONCENTRATION IN RUNOFF

OHIO RIVER AND GREAT LAKES DRAINAGE BASINS

LEGEND

PROPORTION OF DRAINAGE AREA IN CULTIVATED AND IDLE LAND

- ⊙ Over two-thirds
- ⊡ One-third to two-thirds
- ◇ Less than one-third

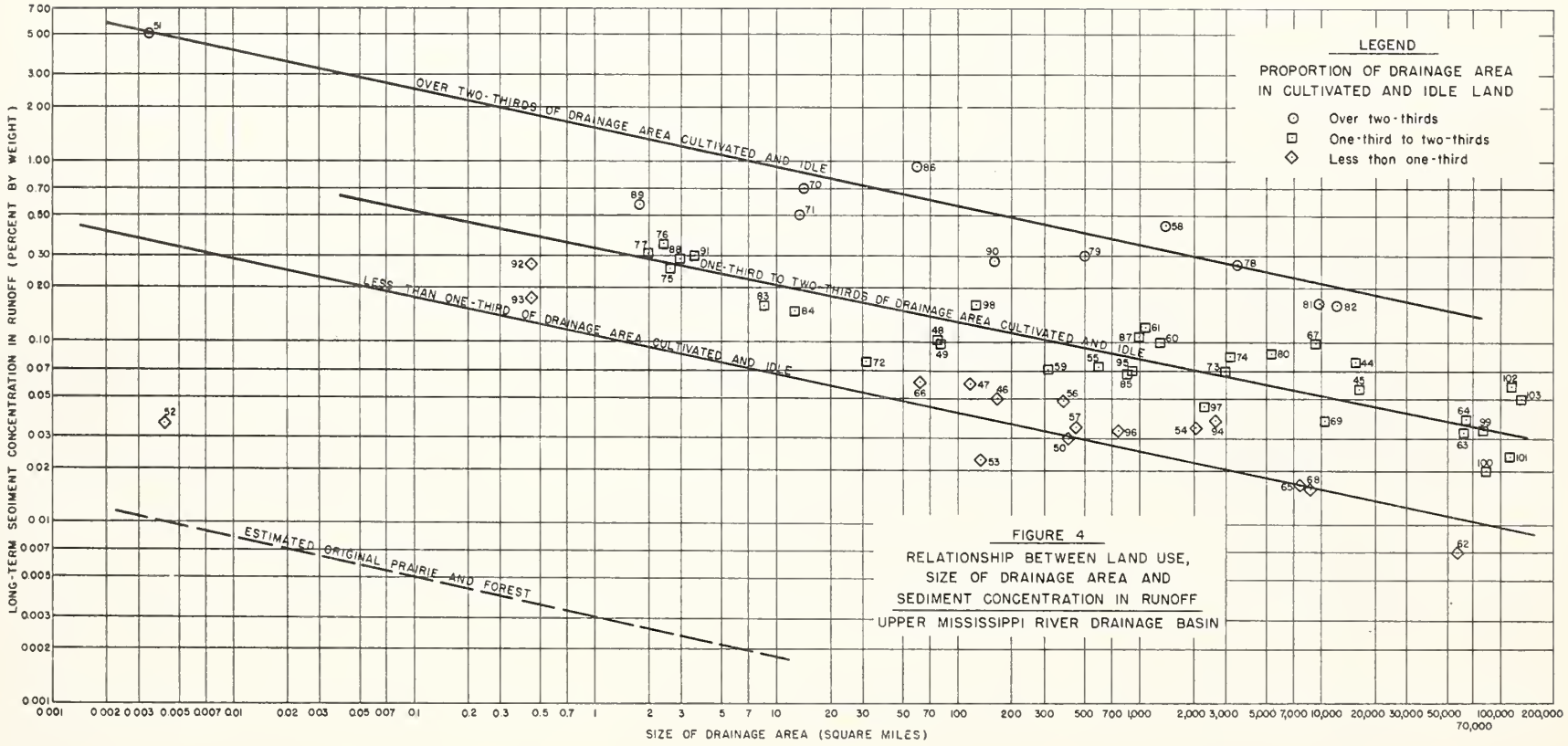


FIGURE 4

RELATIONSHIP BETWEEN LAND USE, SIZE OF DRAINAGE AREA AND SEDIMENT CONCENTRATION IN RUNOFF

UPPER MISSISSIPPI RIVER DRAINAGE BASIN

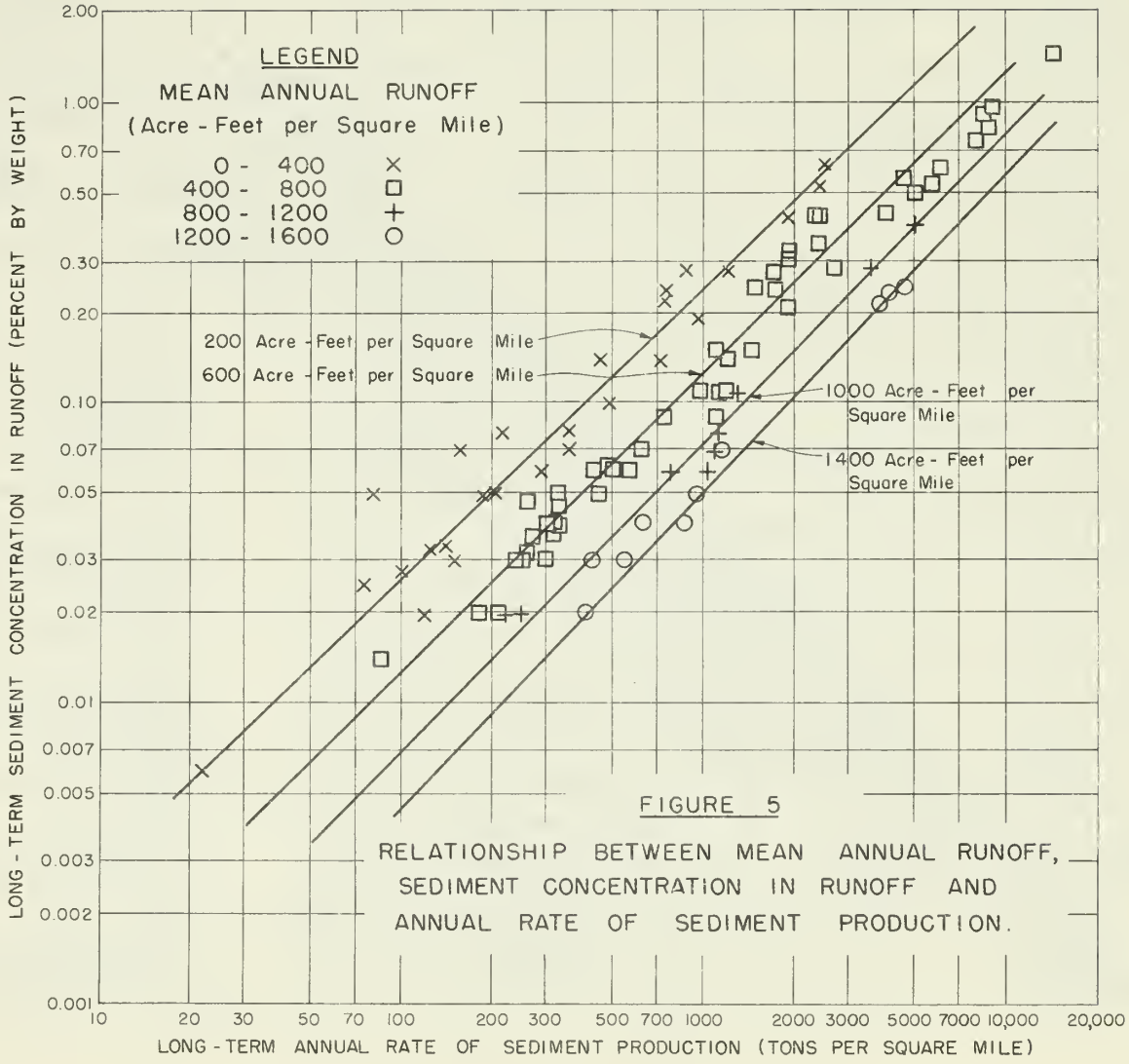
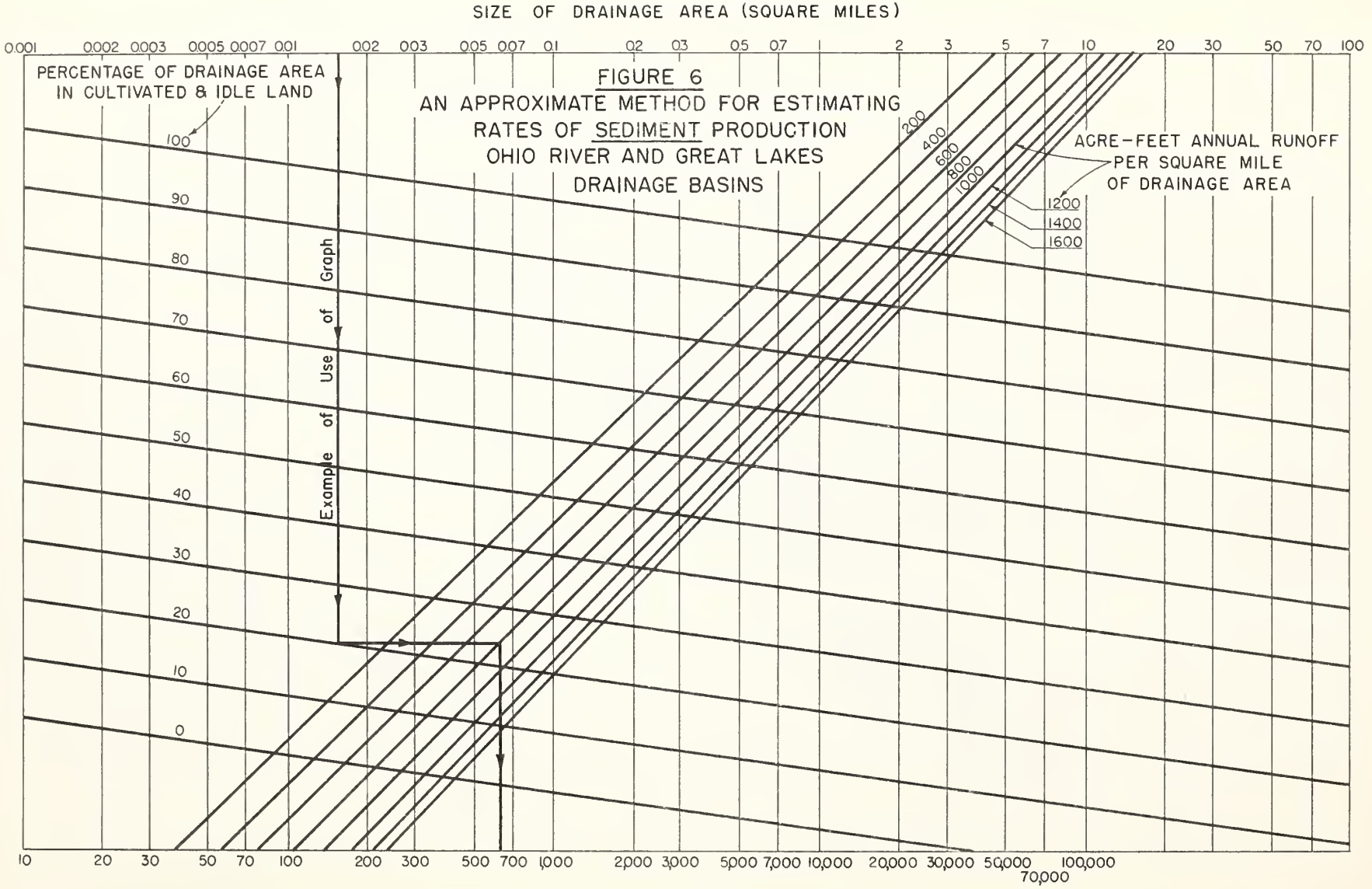


FIGURE 5

RELATIONSHIP BETWEEN MEAN ANNUAL RUNOFF, SEDIMENT CONCENTRATION IN RUNOFF AND ANNUAL RATE OF SEDIMENT PRODUCTION.


SIZE OF DRAINAGE AREA (SQUARE MILES)
0.001 0.002 0.003 0.005 0.007 0.01 0.02 0.03 0.05 0.07 0.1 0.2 0.3 0.5 0.7 2 3 5 7 10 20 30 50 70 100
PERCENTAGE OF DRAINAGE AREA IN CULTIVATED & IDLE LAND
100
90
80
70
60
50
40
30
20
10
0
Example of Use of Graph
FIGURE 6
AN APPROXIMATE METHOD FOR ESTIMATING RATES OF SEDIMENT PRODUCTION OHIO RIVER AND GREAT LAKES DRAINAGE BASINS
ACRE-FEET ANNUAL RUNOFF PER SQUARE MILE OF DRAINAGE AREA
200
400
600
800
1000
1200
1400
1600
10 20 30 50 70 100 200 300 500 700 1,000 2,000 3,000 5,000 7,000 10,000 20,000 30,000 50,000 70,000 100,000
ESTIMATED LONG-TERM ANNUAL RATE OF SEDIMENT PRODUCTION (TONS PER SQUARE MILE OF DRAINAGE AREA)

oped by the writer and R. E. Allen (9) although the previous graph included only the factors of annual soil loss and capacity of the reservoir per square mile of drainage area.

Since mean annual runoff and long-term sediment concentration vary proportionately, these two factors have been plotted against long-term annual rate of sediment production in Figure 5. The influence of land use has been eliminated in this case by adjusting all sediment concentrations and annual rates of sediment production upward or downward to a theoretical land use in which 50 percent of the drainage area is assumed to be cultivated or idle land. As may be seen, the points for the four classes of mean annual runoff selected line up reasonably well.

The mean, or long-term, annual runoff per square mile used in this study was, as previously mentioned, taken from U. S. Geological Survey Water Supply Papers in most cases. The records used extend back to 1898 in many cases, and to 1908 in most cases. The last 40 to 50 years are considered to be representative of the true long-term average annual runoff. The lines in Figures 3 and 4 entitled "Estimated Original Forest and Prairie" represent in the writer's judgment the geologic norm in terms of annual sediment production. These estimates are based upon the plotted data in Figures 3 and 4 and upon the recent land damage studies. They take into account sediment production from all sources, including streambank erosion and roadside erosion. Mean annual runoff is assumed to have been the same before the advent of white man in this area as it is at present. Since approximately 30 percent of the land in the Ohio River and Great Lakes drainage basins is now cultivated or idle, it is estimated that the present annual rate of sediment production, and erosion, is roughly 50 times the geologic norm. In the Upper Mississippi River drainage basin, where about 42 percent of the land is now cultivated or idle, the present rate of sediment production and erosion is approximately 75 times the geologic norm.

2. Prediction of Rates.

In estimating the long-term annual rate of sediment production to be expected from a watershed in the Midwestern States, Figure 6 should be used for the Ohio River and Great Lakes drainage basins, and Figure 7 for the Upper Mississippi River basin. Figures 2 and 8 and Table 2 will also be required. The size of the drainage area and the percentage of the drainage area in cultivated and idle land must be known.

For example, suppose that it is desired to build a farm pond near Senecaville, Ohio. Suppose that the drainage area is 10 acres, or 0.016 square miles, and that it is planned to keep 20 percent of the drainage area in cultivated and idle land. By consulting Figure 2, it is found that the mean annual runoff is approximately 800 acre-feet per square mile of drainage area. In Figure 6, as shown by the example, we start at the top with 0.016 square miles, read down to the line representing 20 percent of the drainage area cultivated and idle, read across to the line representing 800 acre-feet per square

mile mean annual runoff, and then read down to find a long-term annual rate of sediment production of 620 tons per square mile of drainage area. This is a very general figure.

TABLE 2 -- FACTORS FOR USE IN ESTIMATING RATES OF SEDIMENT PRODUCTION

Resource Area	Factor	Resource Area	Factor
Rough Stony Land	0.10	Chicago-Kankakee Lake Plain	0.80
Cut-over Area	0.90	Lansing-Kosciusko	0.35
Iron River-Vilas	0.35	Hillsdale-Miami-Cardington	0.55
Menominee-Tahquemenon	0.20	Miami-Russell	0.55
Superior-Kewanee	1.00	Glacial Sandstone and Shale	0.80
Dells	1.00	Cincinnati-Clermont	0.45
Big Stone	0.35	Ohio Hills	1.35
Clarion-Webster	0.90	Adirondack Highlands	1.10
Carrington-Clyde	1.45	Ontario Lowland	0.60
Tama-Fayette-Dubuque (Driftless Area)	1.45	Allegheny Plateau	0.70
Oconomowoc-Rock River	0.90	Ridge and Valley	0.80
Marshall	2.80	Northeastern Cumberland Plateau	1.35
Shelby-Putnam-Lindley	1.55	Eden Hills and Blue Grass	1.35
Tama	1.80	Highland Rim	0.35
Central Illinois Deep Loess	1.45	Sandstone and Shale (Coal Measures)	1.35
Ozarks	1.00	Nashville Basin	0.45
Flanagan-Elliot-Saybrook	0.55	Mississippi-Wabash Bottoms	0.65
Cisne-Bluford	0.45	Huron-Erie Lake Plain	0.45

Now, by consulting Figure 8, we find that Senecaville lies in the Basic Resource Area called "Ohio Hills". Table 2 gives a factor of 1.35 for this Basic Resource Area. By multiplying the 620 tons per square mile obtained in Figure 6 by this factor of 1.35, we find that

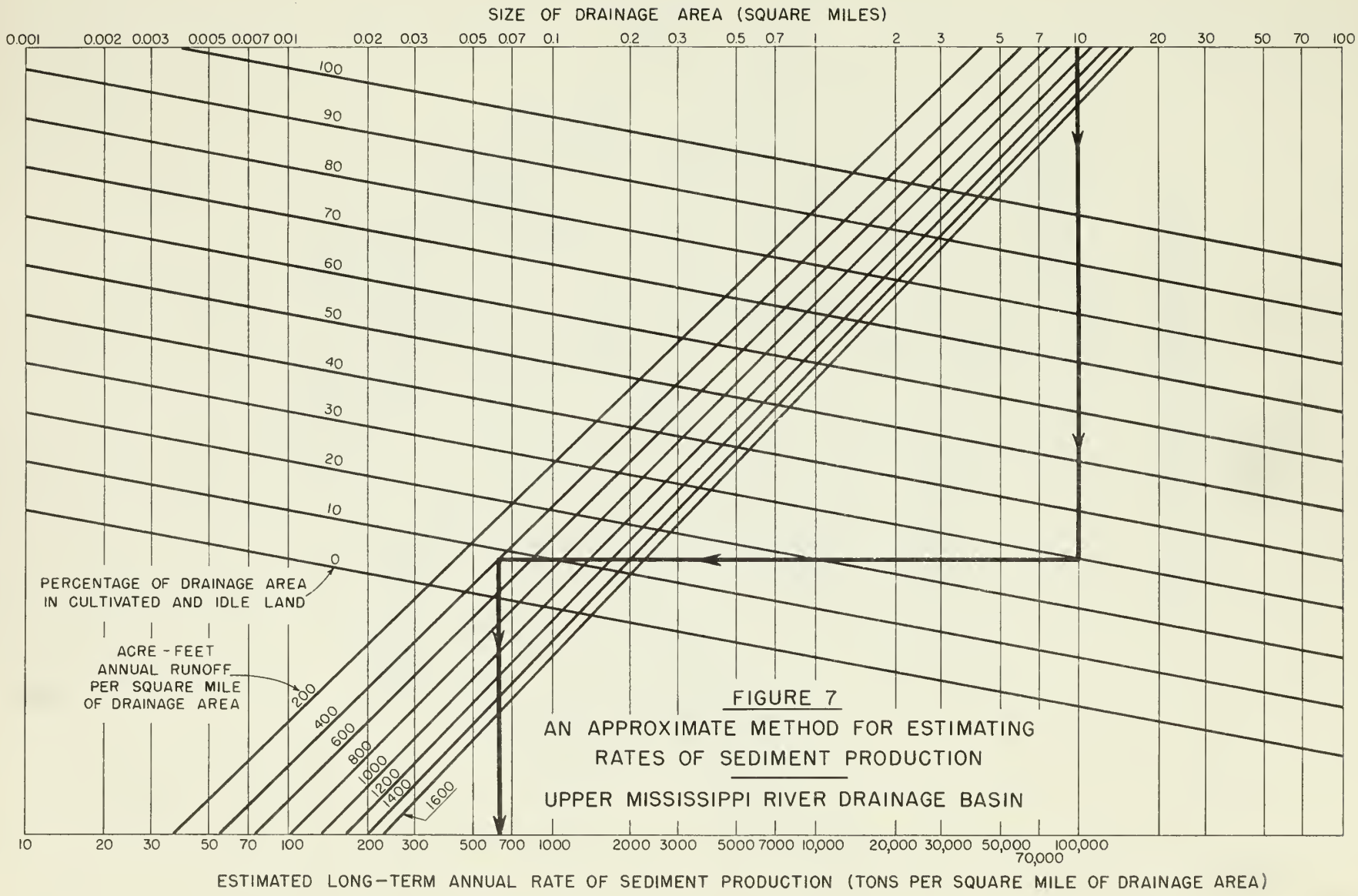

SIZE OF DRAINAGE AREA (SQUARE MILES)
0.001 0.002 0.003 0.005 0.007 0.01 0.02 0.03 0.05 0.07 0.1 0.2 0.3 0.5 0.7 1 2 3 5 7 10 20 30 50 70 100
100 90 80 70 60 50 40 30 20 10 0
PERCENTAGE OF DRAINAGE AREA IN CULTIVATED AND IDLE LAND
ACRE-FEET ANNUAL RUNOFF PER SQUARE MILE OF DRAINAGE AREA
200 400 600 800 1000 1200 1400 1600
10 20 30 50 70 100 200 300 500 700 1000 2000 3000 5000 7000 10,000 20,000 30,000 50,000 70,000 100,000
ESTIMATED LONG-TERM ANNUAL RATE OF SEDIMENT PRODUCTION (TONS PER SQUARE MILE OF DRAINAGE AREA)

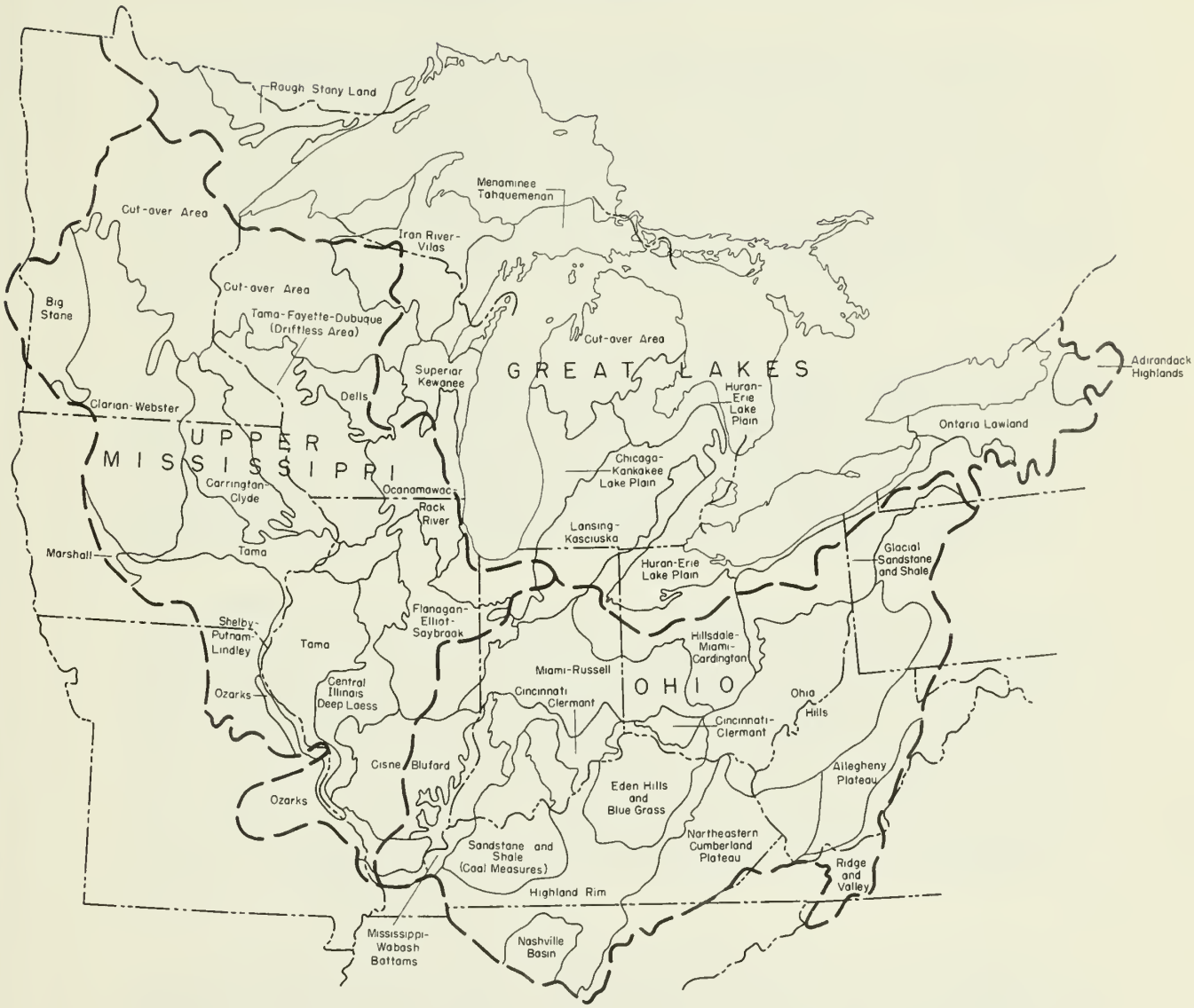
FIGURE 7

AN APPROXIMATE METHOD FOR ESTIMATING RATES OF SEDIMENT PRODUCTION

UPPER MISSISSIPPI RIVER DRAINAGE BASIN

FIGURE 8

MAJOR BASIC RESOURCE AREAS



the long-term annual rate of sediment production for this Basic Resource Area is 840 tons per square mile of drainage area. Since the drainage area in this case is only 0.016 square miles, approximately 13.4 tons of sediment may be expected to reach the pond annually, under existing methods of farming. A certain proportion of this sediment will pass through the pond and over the spillway, depending on the trap efficiency of the pond.

By checking this method of estimation against known rates of sediment production, it has been found that the values obtained may vary, because of unevaluated factors, from 35 to 250 percent of the actual rate of sediment production. As already mentioned, Figures 6 and 7, which were developed from Figures 3 and 4, take into account the factors of land use, size of drainage area, and mean annual runoff. The factors given in Table 2, based upon the recent nation-wide land damage studies, represent the effect of predominant soil types, degree of slopes, length of slopes, and type of rotation in each Basic Resource Area.

There are several other factors influencing sediment production rates, which could not be evaluated in this study. Shape of drainage area is one of them. Grand Lake (Record 42) may be cited as an example. This lake, situated on a divide, has a dam at each end, and a more or less circular drainage area. A large number of short streams feed directly into the lake from all directions, with the result that its rate of sediment production is higher than might otherwise be expected.

Another factor not evaluated is drainage density; that is, the number of miles of uninterrupted stream channel per square mile of drainage area. Also, if the soil type, degree or length of slope, or type of rotation differ markedly from the predominant conditions in the Basic Resource Area in question, an error will be introduced. These unevaluated factors are the cause of the wide variations from the true rate of sediment production which may be obtained in using this method of estimation. This method is submitted for what it is worth, however, with the hope that some day it may be possible to evaluate exactly every factor which influences rates of sediment production in the Midwestern States.

It must also be borne in mind that this study is based upon existing methods of farming. Experiment station studies (unpublished) indicate that where contour farming is substituted for straight-row farming, erosion and sediment production will usually be reduced by 30 to 50 percent. If strip-cropping is added, the reduction will range from 50 to 80 percent. If terraces are built, a reduction of 75 to 95 percent may be expected. Even on rivers such as the Chippewa River, whose sandy sediment is largely bed load, the rate of sediment production can be greatly reduced by structural and vegetative control of the stream banks, valley trenches, and gullies.

F. NOTES ON RECORDS USED IN TABLES 3 AND 4

Record Number

OHIO RIVER BASIN

(1) Flood-control reservoir. Data from detailed sedimentation survey by Pittsburgh District, Corps of Engineers, Department of the Army, in August-September 1945 (32). Twenty-four ranges. Original storage capacity 91,000 acre-feet total, and 4,510 to 6,430 acre-feet in conservation pool. Original lake area, 2,030 acres full, and 475 acres at conservation pool level. Storage began October 28, 1940. Total sediment at date of survey measured 91.6 acre-feet. One hundred ninety square miles of drainage area occupied by Crooked Creek SCS Demonstration Project from April 1935 to July 1937.

(2) Power Reservoir. Data from SCS reconnaissance sedimentation survey made October 10, 1937 (14, p. 13). Twenty-five sediment measurements on 11 ranges. Reported original storage capacity 27,000 acre-feet. Original lake area 690 acres. Storage began 1924. Estimated total sediment at date of survey 486 acre-feet.

(3) Industrial water supply reservoir. Data from SCS reconnaissance sedimentation survey made September 29, 1937 (14, p. 13). Twenty-six sediment measurements. The original storage capacity 35,295 acre-feet. Original lake area 887 acres. Storage began January 1912. Estimated total sediment at date of survey 882 acre-feet.

(4) Water supply reservoir. Data from SCS reconnaissance sedimentation survey made September 30, 1937 (14, p. 13). Eleven sediment measurements. Original storage capacity 2,492 acre-feet. Original lake area 64 acres. Storage began 1914. Estimated total sediment at date of survey 60 acre-feet.

(5) Industrial water supply reservoir. Data from SCS reconnaissance sedimentation survey made September 30, 1937 (14, p. 13). Thirteen sediment measurements. Original storage capacity 3,453 acre-feet. Original lake area 120 acres. Storage began 1905. Estimated total sediment at date of survey 138 acre-feet.

(6) Power Reservoir. Unpublished data from SCS reconnaissance reservoir sedimentation survey made June 27, 1939. Forty sediment measurements. Original storage capacity 106,337 acre-feet. Storage began 1925. Estimated total sediment at date of survey 117 acre-feet.

(7) Water supply reservoir. Data from SCS reconnaissance sedimentation survey made November 17, 1937 (14, p. 13). Fourteen sediment measurements. Original storage capacity 770 acre-feet. Original lake area 55 acres. Storage began 1905. Estimated total sediment at date of survey 270 acre-feet.

(8) Water supply reservoir. Unpublished data from SCS reconnais-

sance sedimentation survey made November 16, 1937. Sixteen sediment measurements. Original storage capacity 612 acre-feet. Original lake area 80.8 acres. Storage began March 1887. Estimated total sediment at date of survey 159 acre-feet.

(9) Recreational lake. Data from SCS reconnaissance sedimentation survey made June 29, 1939 (14, p. 13). Nineteen sediment measurements. Estimated original storage capacity 150 acre-feet. Original lake area about 20 acres. Storage began 1908. Estimated total sediment at date of survey 12 acre-feet.

(10) Flood control and navigational reservoir. Data from detailed sedimentation survey by Pittsburgh District, Corps of Engineers, Department of the Army, made October 1944 to November 1945 (33). Forty ranges. Original storage capacity 290,000 acre-feet total, 11,200 acre-feet minimum pool. Original lake area 3,440 acres total, 660 acres minimum pool. Storage began February 1938. Total sediment measured 384 acre-feet.

(11) Recreational reservoir. Unpublished data from detailed sedimentation survey by Louisville District, Corps of Engineers, Department of the Army, made November 1945. Detailed survey also made in April 1942 but not considered in this study. Thirty-eight ranges. Storage began October 1937. Original storage capacity not known accurately. Capacity in December 1939, when survey ranges were established, was 288 acre-feet. Original lake area 35 acres. Total sediment measured (1939-45) 56 acre-feet.

(12) Recreational pond. Unpublished data from SCS reconnaissance sedimentation survey made November 17, 1939. Three ranges. Original storage capacity 4.43 acre-feet. Original lake area 2.0 acres. Storage began October 3, 1938. Estimated total sediment at date of survey 0.22 acre-foot.

(13) Recreational pond. Unpublished data from SCS reconnaissance sedimentation survey made November 16, 1939. Four ranges. Original storage capacity 15.16 acre-feet. Original lake area 2.3 acres. Storage began October 29, 1938. Estimated total sediment at date of survey 0.14 acre-foot.

(14) Recreational pond. Unpublished data from SCS reconnaissance sedimentation survey made November 17, 1939. Six ranges. Original storage capacity 17.95 acre-feet. Original lake area 3.5 acres. Storage began 1928. Estimated total sediment at date of survey 2.55 acre-feet.

(15) Flood control and recreational reservoir. Data from detailed sedimentation survey by Huntington District, Corps of Engineers, Department of the Army, made February-March 1945 (31). Twenty-two ranges. SCS reconnaissance survey also made in December 1939 but was not considered in this study. Storage began October 10, 1936. Original storage capacity 88,500 acre-feet total,

42,775 conservation pool. Original lake area 5,170 acres total, 3,548 acres conservation pool. Total sediment measured 833 acre-feet. This is equivalent to 949 tons per square mile annually. Suspended sediment measurements from January 1, 1939 to January 29, 1942, taken at intervals varying from twice a day to once a week, show 77 tons per square mile annually passing the spillway. Total load is therefore 1,026 tons per square mile annually. Runoff was approximately the same amount above normal in both the period covered by the reservoir survey and that covered by the suspended sediment measurements. Reservoir trap efficiency 93 percent.

(16) Recreational reservoir. Data from detailed sedimentation survey by R. H. Mitchell and G. Robert Hall of Muskingum College made in fall of 1935. (10, p. 24 and 28). Storage began 1915. Original storage capacity 9.41 acre-feet. Original surface area 0.94 acres. Total sediment measured 2.36 acre-feet.

(17) Experimental watershed. Data from detailed measurements by Northwest Appalachian Soil Conservation Experiment Station (2). Sediment collecting box and Ramser sampler used. Watershed entirely cultivated, approximately on contour, with corn-wheat-meadow rotation. Period of measurement July 1, 1933 to July 1, 1939. Total sediment measured 341 tons.

(18) Experimental watershed. Data from detailed measurements by Northwest Appalachian Soil Conservation Experiment Station (2). Sediment collecting box and Ramser sampler used. Watershed entirely good pasture. A small part of the watershed is colluvial soil. Period of measurement July 1, 1933 to July 1, 1939. Total sediment measured 2.86 tons.

(19) Unpublished data from SCS reconnaissance reservoir sedimentation survey made November-December 1938. Grid system used for sediment measurements. Storage began 1923. Original storage capacity 54 acre-feet. Original lake area 8.0 acres. Estimated total sediment measured 11 acre-feet. Dam failed earlier in 1938, but little sediment lost.

(20) Recreational lake. Unpublished data from SCS reconnaissance sedimentation survey made November-December 1938. Grid system used for sediment measurements. Storage began 1927. Original storage capacity 121 acre-feet. Original lake area 19.0 acres. Estimated total sediment at date of survey 41 acre-feet.

(21) Water supply reservoir. Unpublished data from reconnaissance sedimentation survey made in 1938 by City of Barberton. Storage began 1926. Original storage capacity 2,056 acre-feet. Original lake area about 100 acres. Estimated total sediment at date of survey 368 acre-feet. Some dredging since 1934.

(22) Flood control and recreational reservoir. Data from detailed sedimentation survey by Huntington District, Corps of Engineers, Department of the Army, made February 1945 (30).

Seventeen ranges. SCS reconnaissance survey also made in December 1939, but not considered in this study. Storage began October 1938. Original storage capacity 87,700 acre-feet total, 13,500 conservation pool. Original conservation pool area 850 acres. Total sediment measured 276 acre-feet.

(23) Recreational lake. Unpublished data from SCS reconnaissance sedimentation survey made December 8, 1939. Seven ranges. Original storage capacity 91.6 acre-feet. Original lake area 14.3 acres. Storage began summer 1922. Estimated total sediment at date of survey 11.7 acre-feet. Four samples taken for mechanical analysis showed average 77 percent of sediment finer than 0.031 mm (coarse silt).

(24) Power reservoir. Data from SCS reconnaissance sedimentation survey made July 1944 (14). Sixty-nine sediment measurements on 13 ranges. Storage began August 1934. Original storage capacity 1,646 acre-feet. Original lake area 113 acres. Estimated total sediment at date of survey 628 acre-feet.

(25) Water supply reservoir. Data from detailed sedimentation survey made in September-December 1942 by the Division of Water, City of Columbus (41). Sixty-five ranges. Detailed survey also made in 1934 by Ohio State University (11) but not considered in this study. Storage began fall 1925. Original storage capacity 16,673 acre-feet. Original lake area 829 acres. Total sediment measured 2,135 acre-feet.

(26) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made October 15, 1937. Storage began 1931. Original storage capacity 127.5 acre-feet. Estimated total sediment measured 6 acre-feet.

(27) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made November 6, 1937. Storage began 1930. Original storage capacity 112.5 acre-feet. Estimated total sediment at date of survey 7 acre-feet.

(28) Dry flood control reservoir. Data from detailed sedimentation survey by Miami Conservancy District in 1942 (23, p. 46). Total original storage capacity 312,000 acre-feet. Total original lake area 7,900 acres. Storage began 1921, but survey ranges not established until 1927. Total sediment measured (1927-1942) 352 acre-feet. Specific weight measurement is average of 2 samples (39, p. 25, and 20).

(29) Dry flood control reservoir. Data from detailed sedimentation survey by Miami Conservancy District in 1942 (23, p. 46). Total original storage capacity 106,000 acre-feet. Total original lake area 3,600 acres. Storage began 1920, but survey ranges not established until 1927. Total sediment measured (1927-1942) 382 acre-feet. Specific weight measurement is average of 2 samples. (39, p. 25, and 20).

(30) Power reservoir. Unpublished data from SCS reconnaissance sedimentation survey made October 1941 by range method. Storage began October 1925. Original storage capacity 258,949 acre-feet. Original surface area 2,560 acres. Estimated total sediment at date of survey 3,243 acre-feet.

(31) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made October 1941 by range method. Storage began October 1902. Original storage capacity 114 acre-feet. Estimated total sediment at date of survey 19.4 acre-feet.

(32) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made November 5, 1937. Storage began 1913. Original storage capacity 2,701 acre-feet. Estimated total sediment at date of survey 432 acre-feet.

(33) Suspended load and turbidity records. Unpublished data from Louisville District, Corps of Engineers, Department of the Army, for period from May 5, 1943 to May 5, 1944. Suspended load samples taken at daily to weekly intervals with the Ohio River Division sampler, during periods of high and medium discharge. Each sampling consisted of 12 to 30 point samples taken through the entire river cross-section. Comparative field tests indicate that this sampler collects approximately the same amount of sediment as the D-43 sampler (40, p. 39). Turbidity records used for low-discharge periods. Suspended load and discharge records from Metropolis, Illinois. Turbidity records from Kentucky Ordnance Works, west of Paducah, Kentucky.

(34) Water supply reservoir. Data from reconnaissance sedimentation survey made December 1908 by the St. Bernard Mining Company (1). Storage began December 1888. Original storage capacity 1,228 acre-feet. Original surface area 101 acres. Total sediment measured 43.8 acre-feet.

(35) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made September 30-October 3, 1940. Sixty sediment measurements on 12 ranges. Storage began June 1915. Original storage capacity 1,226 acre-feet, increased to 8,643 acre-feet in July 1925. Original lake area 300 acres, increased to 875 acres in July 1925. Estimated total sediment at date of survey 1,205 acre-feet.

(36) Power reservoir. Unpublished data from SCS reconnaissance sedimentation survey made August 30-31, 1940. Sixty-six sedimentation measurements on 17 ranges. Storage began June 1923. Original storage capacity 14,722 acre-feet. Original lake area 1,400 acres. Estimated total sediment at date of survey 683 acre-feet, including a delta of 2 acre-feet.

(37) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made September 27, 1940. Thirty-

eight sediment measurements on 7 ranges. Storage began August 1927. Original storage capacity 306 acre-feet. Original lake area 93.4 acres. Estimated total sediment at date of survey 45.9 acre-feet.

(38) Water supply reservoir. Unpublished data based on SCS reconnaissance sedimentation survey made October 21, 1940. Twenty-nine sediment measurements on 6 ranges. Storage began July 1894. Original storage capacity 137 acre-feet. Original lake area 24.5 acres. Estimated total sediment at date of survey 18 acre-feet. In September 1926 a dam built downstream raised water level to 0.6 foot above spillway of this dam.

(39) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made September 6, 1940. Thirty-seven sediment measurements on 8 ranges. Storage began 1921. Original storage capacity 1,025 acre-feet. Original lake area 87 acres. Estimated total sediment at date of survey 15 acre-feet.

(40) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made November 19, 1940. Storage began March 1915. Original storage capacity 1,313 acre-feet. Original lake area 80 acres. Estimated total sediment at date of survey 34 acre-feet.

(41) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made January 1941. Storage began 1907. Original storage capacity 635 acre-feet. Total sediment measured 167 acre-feet.

GREAT LAKES BASIN

(42) Recreational reservoir. Unpublished data from SCS reconnaissance sedimentation survey made August 19-28, 1940. Seventy-four sediment measurements on 8 ranges. Storage began 1844 (as a water supply for the Ohio canal system). Original storage capacity was 220,400 acre-feet. Storage capacity in 1856 was reduced to 130,175 acre-feet, when spillway level was lowered 5.4 feet. Original lake area 17,603 acres. Lowered to 15,748 acres in 1856. Dam at each end of lake. Drains into both St. Mary's and Wabash Rivers. Estimated total sediment at date of survey 23,565 acre-feet.

(43) Water supply reservoir. Unpublished data from detailed sedimentation survey made by City of Ithaca in 1941. Detailed surveys also made in 1925, 1934, 1936, and 1938, but not considered in this study. Storage began 1910. Original storage capacity 1,105 acre-feet (at elevation 705.2). Original lake area 52.5 acres. Total sediment measured 286 acre-feet. Desilting reservoir built above reservoir but washed out July, 1935.

UPPER MISSISSIPPI RIVER BASIN

(44) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933, by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface samplings with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(45) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(46) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(47) Suspended load (15). Samples taken from June 1, 1934 to May 31, 1938 by U. S. Geological Survey with the brass pipe sampler. Sampling intervals varied from one hour during rapidly rising stages to one day during periods of low water. Located in SCS Demonstration Project. The sampler used is believed to collect less sediment under most conditions than the D-43, although the exact relationship is not known.

(48) Suspended load (15). Samples taken from June 1, 1934 to May 31, 1940 by U. S. Geological Survey with the brass pipe sampler. Intervals varied from one hour during rapidly rising stages to one day during period of low water. Located in SCS Demonstration Project. The sampler used is believed to collect less sediment under most conditions than the D-43, although the exact relationship is not known.

(49) Suspended load (15). Samples taken from June 1, 1934 to May 31, 1940 by U. S. Geological Survey with the brass pipe sampler. Sampling intervals varied from one hour during rapidly rising stages to one day during periods of low water. Located in SCS Demonstration Project. The sampler used is believed to collect less sediment under most conditions than the D-43, although the exact relationship is unknown.

(50) Suspended load (29). Sampling done from June 1, 1932 to May 31,

1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(51) Experimental watershed. Data from detailed measurements by Upper Mississippi Valley Soil Conservation Experiment Station (16). Watershed entirely cultivated with corn-barley-hay rotation. Slopes average 15 percent. Period of measurement Jan. 1, 1934 to Dec. 31, 1938. Sediment was collected in a box 6 by 16 by 2 feet in size. Approximately 1/150 of the runoff overflowing the box was caught in a Ramser sampler. After each storm, sediment samples from both the box and the Ramser sampler were weighed to convert volumes to tons. The box and sampler were then cleaned out in readiness for the next storm. Total sediment measured 586 tons.

(52) Experimental watershed. Data from detailed measurements by Upper Mississippi Valley Soil Conservation Experiment Station (16). Watershed entirely in pasture. Slopes average 24 percent. Period of measurement Jan. 1, 1934 to Dec. 31, 1938. Sediment was collected in a box 6 by 16 by 2 feet in size. Approximately 1/150 of the runoff overflowing the box was caught in a Ramser sampler. After each storm, sediment samples from both the box and the Ramser sampler were weighed to convert volume to tons. The box and sampler were then cleaned out in readiness for the next storm. Total sediment measured 4.98 tons.

(53) Power reservoir. Unpublished data from SCS detailed sedimentation survey made June 22, 1939. Twenty-two ranges. Storage began 1867. Original storage capacity 1,677 acre-feet. Original surface area 277.9 acres. Total sediment measured 1,474 acre-feet, including 479 acre-feet of above-crest deposits and sediment dredged from lake. Specific weight determination is average of 14 samples, including some from above-crest deposits. Suspended load samples were taken from April 12 to November 3, 1940, both at the head of the lake and at the dam. Sampling intervals varied from hourly during rising stages to once in three days during low discharge periods. These studies indicated a trap efficiency of 86 percent during this period, in which no large floods occurred. Annual sediment accumulation in reservoir during period, per square mile of drainage area, was 234 tons. Annual sediment load passing spillway during period was approximately 38 tons per square mile. Total annual load during period is therefore 272 tons per square mile.

(54) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for

this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(55) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(56) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(57) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(58) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(59) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(60) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during

winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(61) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(62) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler. Long-term estimate does not include allowance for sediment trapped by upstream navigation reservoirs.

(63) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface sampling, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler. Long-term estimate does not include allowance for sediment trapped by upstream navigation reservoirs.

(64) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly 2-point measurements (2/10 and 8/10 depth). Some precise measurements, using verticals spaced 150 feet apart with 5 points on each vertical (surface, 2/10, 5/10, 8/10, and bottom), and some surface sampling. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler. Long-term estimate does not include allowance for sediment trapped by upstream navigation reservoirs.

(65) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface measurements, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under

most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(66) Power and recreational reservoir. Unpublished data from SCS reconnaissance sedimentation survey made October 1941. Areas of equal sediment depth contoured. Storage began 1926. Original storage capacity 683 acre-feet. Original lake area 79 acres. Estimated total sediment at date of survey 226 acre-feet.

(67) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface measurements, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. U. S. Army Engineers, on basis of laboratory studies, estimate that bed load is 84 percent of total sediment load at this point. Allowance has been made for bed load in estimating long-term annual rate of sediment production. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(68) Power reservoir. Data from sedimentation survey made by St. Paul District, Corps of Engineers, Department of the Army, in 1933, (29), p. 44. The 1933 survey included sounding of 12 ranges established in 1906, and establishment of 128 additional ranges. Storage began 1914. Original storage capacity approximately 100,000 acre-feet. Estimated total sediment at date of survey 8,149 acre-feet. Several reservoirs of very low trap efficiency upstream.

(69) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface measurements, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Lake Wisconsin (Record 68) is estimated to trap 50 percent of sediment reaching it. Allowance has been made for this trapped sediment in estimating long-term annual rate of sediment production. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler.

(70) Recreational reservoir. Data from detailed sedimentation survey by Iowa State Conservation Commission made in winter 1932 (10, p. 24). Storage began 1924. Original storage capacity 738 acre-feet. Original surface area 65 acres. Total sediment measured 186 acre-feet.

(71) Desilting reservoir. Unpublished data from detailed sedimentation survey by SCS and Iowa State Conservation Commission made September 1947. Seven ranges. Storage began May 1934. Original storage capacity 660 acre-feet. Original lake area 69.9

acres. Total sediment measured 208 acre-feet.

(72) Recreational reservoir. Unpublished data from detailed sedimentation survey by Iowa State Conservation Commission in 1946. Contour method used. Storage began 1934, but original contour survey not made until 1935. Storage capacity in 1935 was 1,154 acre-feet. Original surface area 105.9 acres. Total sediment measured (1935-1946) 84 acre-feet.

(73) Suspended load. Unpublished data from sampling done by U. S. Geological Survey from Oct. 1, 1943 to Sept. 30, 1946. Samples collected with standard D-43 sampler one to three times daily and oftener during flood periods. No sampling during winter months, but an estimate for this period has been made, using Records 74 and 81, and has been included in measured sediment production.

(74) Suspended load. Unpublished data from sampling done by U. S. Geological Survey from Oct. 1, 1943 to Sept. 30, 1946. Samples collected with standard D-43 sampler one to three times daily and oftener during flood periods.

(75) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made 1934. Storage began 1925. Original storage capacity 261 acre-feet. Original surface area 40 acres. Estimated total sediment at date of survey 37 acre-feet. City now cooperating in soil conservation program.

(76) Railroad water supply reservoir. Unpublished data from detailed sedimentation survey made by C. M. St.P. and P. Railway in 1918. Storage began 1903. Original storage capacity 43 acre-feet. Total sediment measured 18 acre-feet.

(77) Recreational reservoir. Unpublished data from detailed sedimentation survey by Iowa State Conservation Commission in 1946. Storage began 1936. Original storage capacity 185 acre-feet. Original surface area 17 acres. Total sediment measured 13 acre-feet.

(78) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from March 19, 1940 to Sept. 30, 1945. Sampling interval varied from 6 hours during rising stages to one week during periods of low flow. Sampling done during winter of 1940-1941, estimated for winter months in other years, and included in sediment production. The type of Rock Island sampler used during this period collected approximately 20 percent sediment in excess of the D-43 sampler. Allowance was made for this error in making long-term estimate of sediment production.

(79) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from August 1, 1944 to Sept. 30, 1945. Sampling interval varied from 3 hours during rising stages to 1 day during periods

of low flow. No sampling during winter months, but estimate included in sediment production. The type of Rock Island sampler used during this period collected approximately 13 percent sediment in excess of the D-43 sampler. Allowance was made for this error in making long-term estimate of sediment production.

(80) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from March 19, 1940 to Sept. 30, 1945. Sampling interval varied from 5 hours during rising stages to one week during periods of low flow. Little sampling during winter months, but estimate included in sediment production. Records from Des Moines River at Tracy (Record 82) used in filling small gaps in record. The types of Rock Island sampler used during this period collected approximately 22 percent sediment in excess of the D-43 sampler. Allowance was made for this error in making long-term estimate of sediment production.

(81) Suspended load. Unpublished data from sampling done by U. S. Geological Survey from Oct. 1, 1944 to Sept. 30, 1947. Samples collected with standard D-43 sampler one to three times a day and oftener during flood periods.

(82) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from March 20, 1940 to Sept. 30, 1947. Sampling interval varied from 6 hours during rising stages to one week during periods of low flow. No sampling in winter months, but estimate included in sediment production. Records from Des Moines River at Boone (Record 80) used in filling in small gaps in record. The types of Rock Island sampler used during this period collected approximately 13 percent sediment in excess of the D-43 sampler. Allowance was made for this error in making long-term estimate of sediment production.

(83) Water supply and recreational reservoir. Data from SCS detailed sedimentation survey made July-August 1936 (6, pp. 60-61, and 18). Thirty ranges. Storage began December 1, 1923. Original storage capacity 2,881 acre-feet. Original surface area 186 acres. Total sediment measured 221 acre-feet.

(84) Recreational lake. Data from SCS detailed sedimentation survey made July-August 1936 (6, p. 60, and 13). Ten ranges. Storage began September 1, 1924. Original storage capacity 286 acre-feet. Original surface area 46.1 acres. Total sediment measured 149 acre-feet.

(85) Water supply reservoir. Data from SCS detailed sedimentation survey made May 1946 (6). Fifty-three ranges. SCS detailed survey also made in May 1936, but not considered in this study (12). Storage began April 16, 1922. Original storage capacity 19,738 acre-feet. Original surface area 2,805 acres. Total sediment measured 5,171 acre-feet. Average specific weight is

based on analysis of 21 sediment samples. Annual sediment accumulation during period per square mile of watershed was 266 tons. A study of turbidity records indicates that about 75 tons per square mile annually passed over the spillway or were removed in filtration plants. The total annual sediment load per square mile was therefore 341 tons. The reservoir has a trap efficiency of 78 percent.

(86) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made October 1941. Six ranges. Storage began 1929. Original storage capacity 8,614 acre-feet. Original lake area 530 acres. Estimated total sediment at date of survey 1,060 acre-feet.

(87) Suspended load. Unpublished data from sampling done by St. Louis District, Corps of Engineers, Department of the Army, and U. S. Geological Survey from October 30, 1942 to October 10, 1944, and from July 1, 1945 to June 30, 1946. Sampling interval varied from one hour during rising stages to one week during periods of low flow. Number of samples taken at each sampling varied from 1 to 5. No comparative tests have been made of the brass pipe sampler used and the D-43.

(88) Water supply reservoir. Unpublished data from SCS reconnaissance sedimentation survey made May 1936. Storage began February 1926. Dam failed June 1935, rebuilt June 1936. Period from June 1935 to May 1936, the date of the survey, was not included in the period of record. Original storage capacity 804 acre-feet. Original surface area 56 acres. Estimated total sediment at date of survey 100 acre-feet.

(89) Water supply reservoir. Data from SCS detailed sedimentation survey made December 1-11, 1946 (6, p. 60). Contour survey, using 13 ranges and 16 random shots. Storage began June 1925. Original storage capacity 367 acre-feet, assuming present spillway level (raised 1.24 feet, to 686.24 feet above m.s.l., in 1944). Original lake area 46.0 acres. Total sediment measured 135 acre-feet. Above-crest deposits insignificant.

(90) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from March 12, 1942 to Sept. 29, 1945. Sampling interval varied from 2 hours during rising stages to one week during periods of low flow. Two types of Rock Island sampler used. Allowance was made for error obtained in using this sampler, using the D-43 sampler as standard, in making long-term estimate of sediment production. The types of sampler used during this period collected an average of 18 percent in excess of the D-43. Drainage area used is exclusive of the drainage area of Pittsfield Reservoir, which has an estimated trap efficiency of 94 percent. Estimated long-term annual bed load production per square mile, as indicated by sand and gravel deposits (larger than 0.062 millimeter) in nearby Hadley Creek desilting basin, is 900 tons, or 26 percent of the total esti-

mated long-term sediment production.

(91) Water supply reservoir. Data from SCS detailed sedimentation survey made Aug. 19 to Sept. 12, 1936 (6, p. 61, and 19). Fourteen ranges. Storage began August 1926. Original storage capacity 1,175 acre-feet. Original surface area 159 acres. Total sediment measured 95 acre-feet. Only insignificant above-crest deposits.

(92) Recreational reservoir. Unpublished data from SCS detailed sedimentation survey made July 25, 1939. Five ranges. Storage began October 1930. Original storage capacity 24.1 acre-feet. Original surface area 3.5 acres. Total sediment measured 4.6 acre-feet, including 0.14 acre-feet of above-crest deposits. Specific weight measurement taken from 3 samples.

(93) Recreational reservoir. Unpublished data from SCS reconnaissance sedimentation survey made July 24, 1939. Storage began 1928. Original storage capacity 8.2 acre-feet. Original surface area 3 acres. Estimated total sediment at date of survey 2.8 acre-feet. Dam failed spring 1938. One year's period, from this time till date of survey, omitted from period of record.

(94) Suspended load. Unpublished data from sampling done by St. Louis District, Corps of Engineers, Department of the Army, and U. S. Geological Survey, from November 7, 1942 to June 30, 1946. Sampling interval varied from 3 hours during rising stages to one week during periods of low flow. Number of samples taken at each sampling varied from 1 to 5. No comparative field tests have been made of the brass-pipe sampler used and the D-43.

(95) Suspended load. Unpublished data from sampling done by St. Louis District, Corps of Engineers, Department of the Army, and U. S. Geological Survey from November 6, 1942 to March 10, 1946. Sampling interval varied from 3 hours during rising stages to one week during periods of low flow. Number of samples taken at each sampling varied from 1 to 5. No comparative field tests have been made of the brass-pipe sampler used and the D-43.

(96) Suspended load. Unpublished data from sampling done by St. Louis District, Corps of Engineers, Department of the Army, and U. S. Geological Survey, from March 7, 1945 to June 30, 1946. Sampling interval varied from 3 hours during rising stages to one week during periods of low flow. Number of samples at each sampling varied from 1 to 7. No comparative field tests have been made of the brass-pipe sampler used and the D-43.

(97) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from February 28, 1942 to September 30, 1945. Sampling interval

varied from 12 hours during rising stages to one week during periods of low flow. No sampling in winter months, but estimate included in sediment production. The types of Rock Island sampler used during this period collected approximately 18 percent sediment in excess of the D-43 sampler. Allowance was made for this error in making long-term estimate of sediment production.

(98) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from March 13, 1942, to September 26, 1945. Sampling interval varied from 2 hours during rising stages to one week during periods of low flow. No sampling during winter months, but estimate included in sediment production. The types of Rock Island sampler used during this period collected approximately 17 percent sediment in excess of the D-43 sampler. Allowance was made for this error in making estimate of long-term sediment production.

(99) Suspended load (29). Sampling done from June 1, 1932 to May 31, 1933 by St. Paul District, Corps of Engineers, Department of the Army. Daily sampling. Chiefly surface measurements, with some 2-point sampling (2/10 and 8/10 depth). No sampling during winter months, but sediment production includes an estimate for this period. Comparative field tests indicate that under most conditions the St. Paul sampler used collects approximately the same amount of sediment as the D-43 sampler. Long-term estimate does not include allowance for sediment trapped by upstream navigation dams.

(100) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from Nov. 11, 1942 to Sept. 25, 1946. Sampling interval varied from one day during rising or high stages, to one week during periods of low flow. Only one sample taken at each sampling, which may or may not represent the entire cross-section. Sediment load estimated for winter months when river was frozen and no sampling done. Two types of Rock Island sampler used, with and without horizontal fins. Allowance was made for error obtained in using this sampler as compared with the D-43 in making long-term estimate of sediment production. The types of sampler used during this period collected an average of 18 percent in excess of the D-43. Long-term estimate does not include allowance for sediment trapped by upstream navigation dams.

(101) Suspended load. Unpublished data from sampling done by Rock Island District, Corps of Engineers, Department of the Army, from Nov. 14, 1942 to Sept. 26, 1946. Sampling interval varied from one day during rising or high stages, to one week during periods of low flow. Only one sample taken at each sampling, which may or may not be representative of entire cross-section. Sediment load estimated for winter months when river was frozen and no sampling done. Two types of Rock Island sampler used,

with and without horizontal fins. Allowance was made for error obtained in using this sampler as compared with the D-43 in making long-term estimate of sediment production. The types of sampler used during this period collected an average of 17 percent in excess of the D-43. Long-term estimate does not include allowance for sediment trapped by upstream navigation dams.

(102) Navigational and power reservoir. Unpublished data from detailed sedimentation survey made in 1936 by Rock Island District, Corps of Engineers, Department of the Army. Twenty-six ranges. Detailed survey also made by U. S. Army Engineers in summer, 1928, but not considered in this study (29). Original storage capacity 479,550 acre-feet. Original surface area 31,000 acres. Original ranges established 1891. Storage began spring 1913. Total sediment measured 144,000 acre-feet.

Suspended load sampling done by Rock Island District, Corps of Engineers, Department of the Army, from August 23, 1943 to Sept. 25, 1946. Sampling interval varied from one day during rising or high stages to one week during periods of low flow. Diurnal fluctuations caused by operation of dam make questionable the value of a single daily sample. Sediment load estimated for winter months when river was frozen and no sampling done. Rock Island sampler without horizontal fins used. Allowance was made for error obtained in using this sampler as compared with the D-43 in making long-term estimate of sediment production. The sampler used during this period collected an average of 13 percent in excess of the D-43. Long-term estimate does not include allowance for sediment trapped by upstream navigation dams.

Annual sediment accumulation in reservoir during period 1913-1936 was 92 tons per square mile. Annual sediment load measured by Rock Island sampler below dam during period 1943-1946 was 137 tons per square mile. Total annual measured sediment production per square mile was therefore 229 tons. Estimated long-term trap efficiency is 50 percent, after measured amounts of reservoir deposits and suspended sediment have been adjusted to normal runoff.

(103) Suspended load. Unpublished data from sampling done by Rock Island District Corps of Engineers, Department of the Army, from Aug. 22, 1943 to May 1, 1945 and June 15, 1946 to Sept. 30, 1946. Sampling interval varied from one day during rising or high stages to one week during periods of low flow. Only one sample taken at each sampling, which may or may not be representative of entire cross-section. Sediment load estimated for winter months when river was frozen and no sampling done. Rock Island sampler without horizontal fins used. Allowance was made for error obtained in using this sampler as compared with the D-43 in making long-term estimate of sediment production. This sampler is estimated to have collected during this period 13 percent in excess of the D-43. However, the extreme depths and high velocities sometimes encountered at

this station are considered to be beyond the best range of the Rock Island sampler. Long-term estimate does not include allowance for sediment trapped in upstream navigation dams.

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1			15	16	17	18	19	20
RECORD NUMBER	DRAINAGE BASIN & STREAM		ESTIMATED SPECIFIC WEIGHT OF SEDIMENT	MEASURED ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE		ESTIMATED PROPORTION OF SEDIMENT PRODUCTION MEASURED	ESTIMATED LONG-TERM ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE	ESTIMATED LONG-TERM SEDIMENT CONCENTRATION IN RUNOFF
			Lb/Cu.Ft.	Acre-Feet	Tons	%	Tons	% by Weight
	OHIO RIVER BASIN							
	ALLEGHENY RIVER							
1	Crooked Creek	Crooked C	60	0.07	91	85	120	0.008
2	Clarion River	Piney Res	60	0.04	51	73	70	0.004
3	Quemahoning Creek	Quemahoni	50	0.38	413	97	425	0.026
4	Salt Lick Run	Salt Lick	60	0.22	290	96	300	0.018
5	Hinckston Run	Hinckston	70	0.41	623	97	640	0.039
	YOUGHIOGHENY RIVER							
6	Deep Creek	Deep Cree	40	0.14	120	100	120	0.006
7	Indian Creek	Indian Cr	75	0.08	126	33	375	0.018
8	Jacob River	Upper Bri	70	0.10	147	65	220	0.015
9	Small Branch	Gorley's	60	0.13	176	75	230	0.011
	MONONGAHELA RIVER							
10	Tygart River	Tygart Re	50	0.05	51	75	130	0.007
	MIDDLE OHIO TRIBUTARIES							
11	Mill Creek	Sharon Wo	55	1.96	2,350	80	2,700	0.40
12	Small Branch	Ohio Pond	40	4.00	3,485	90	3,200	0.32
13	Small Branch	Ohio Pond	40	0.98	851	93	760	0.08
14	Small Branch	Ohio Pond	50	1.45	1,579	85	2,000	0.19
	MUSKINGUM RIVER							
15	Wills Creek	Senecavil	50	0.94	1,026	100	920	0.09
16	Small Branch	Muskingum	70	0.37	562	100	630	0.06
17	Small Branch	Experimen			14,200	100	14,000	1.47
18	Small Branch	Experimen			85	100	85	0.009
19	Small Branch	Tabor Lak	50	1.38	1,510	89	1,700	0.19
20	McGuire Creek	Stoney La	65	0.44	619	54	1,250	0.14
21	Wolf Creek	Barberton	55	1.10	1,320	85	1,410	0.14
22	Clear Fork Mohican Rive	Pleasant	60	0.22	292	90	360	0.041
23	Ford Creek	Robbins L	68	0.14	207	66	320	0.032
	KANAWHA RIVER							
24	Little River	Radford R	65	0.19	269	30	780	0.06
	SCIOTO RIVER							
25	Scioto River	O'Shaughn	65	0.13	184	62	310	0.035
	LICKING RIVER							
26	Bank Lick Creek	Walton Re	50	4.16	4,538	98	4,100	0.33
27	Grassy Creek	Williamst	50	2.13	2,317	96	2,500	0.20
	MIAMI RIVER							
28	Stillwater River	Englewood	77.5	0.04	63	30	230	0.029
29	Twin Creek	Germantow	79.5	0.10	166	30	650	0.07
	KENTUCKY RIVER							
30	Dix River	Herringto	50	0.49	537	98	575	0.04
31	Small Branch	Lake Plac	50	2.62	2,860	98	2,920	0.17
32	East Hickman Creek	No. 4 Res	50	2.26	2,456	97	2,530	0.14
	LOWER OHIO AND TRIBUTARIES							
33	Ohio River	Metropoli			170	90	160	0.018
34	Brown Creek	Loch Mary	60	0.60	782	97	760	0.052
	WABASH RIVER							
35	No. Fork Vermilion River	Vermilion	70	0.18	273	60	455	0.06
36	Tippecanoe River	Shafer La	75	0.02	38	47	100	0.014
37	Conners Branch	Greendale	70	0.14	214	50	400	0.06
38	Small Branch	Huntingbu	40	0.62	537	96	560	0.05
39	Small Branch	Res. No.	40	1.97	1,720	100	1,600	0.15
	CUMBERLAND RIVER							
40	Other Creek	Radnor La	60	0.67	881	98	900	0.049
41	Little River	Lake Tand	60	0.55	720	87	830	0.06
	GREAT LAKES BASIN							
	LAKE ERIE							
42	St. Mary's River	Grand Lak	55	2.64	3,170	100	3,[illegible]	0.46
	LAKE ONTARIO							
43	Six Mile Creek	Potter's	60	0.21	273	68	[illegible]	0.05

TABLE NO.3

TABLE 3 - SEDIMENT RECORDS IN THE OHIO RIVER AND GREAT LAKES BASINS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
RECORD NUMBER	DRAINAGE BASIN & STREAM	POINT OF MEASUREMENT	DRAINAGE AREA	APPROXIMATE LAND USE DURING PERIOD					PERIOD OF RECORD	LENGTH OF RECORD	RELIABILITY OF RECORD	ESTIMATED AVERAGE ANNUAL RUNOFF PER SQUARE MILE		DIFFERENCE BETWEEN RUNOFF DURING PERIOD AND MEAN RUNOFF	ESTIMATED SPECIFIC WEIGHT OF SEDIMENT	MEASURED ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE		ESTIMATED PROPORTION OF SEDIMENT PRODUCTION MEASURED	ESTIMATED LONG-TERM ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE	ESTIMATED LONG-TERM SEDIMENT CONCENTRATION IN RUNOFF
				Cult.	Idle	Past.	Woods	Urban				DUR. PERIOD	MEAN						
			Square Miles	%	%	%	%	%		Years		Acre-Feet	Acre-Feet	%	Lb/Cu.Ft.	Acre-Feet	Tons	%	Tons	% by Weight
	OHIO RIVER BASIN																		
	ALLEGHENY RIVER																		
1	Crooked Creek	Crooked Creek Reservoir, Ford City, Pa.	277	22	2	43	29	4	1940-1945	4.83	9	1,080	1,140	- 5	60	0.07	91	85	120	0.008
2	Clarion River	Pinsy Reservoir, Clarion, Pa.	980	3	1	1	93	2	1924-1937	13	7	1,190	1,160	+ 3	60	0.04	51	73	70	0.004
3	Quemahoning Creek	Quemahoning Reservoir, Johnstown, Pa.	90.6	50	1	7	40	2	1912-1937	25.7	8	1,210	1,210	0	50	0.38	413	97	425	0.026
4	Salt Lick Run	Salt Lick Reservoir, Johnstown, Pa.	11.8	17	3	6	71	3	1914-1937	23	8	1,210	1,210	0	60	0.22	290	96	300	0.018
5	Hinckston Run	Hinckston Run Reservoir, Johnstown, Pa.	10.6	17	3	6	71	3	1905-1937	32	8	1,210	1,210	0	70	0.41	623	97	640	0.039
	YOUGHIOGHENY RIVER																		
6	Deep Creek	Deep Creek Reservoir, Oakland, Md.	58	20	1	10	65	4	1925-1939	14	8	1,570	1,550	+ 1	40	0.14	120	100	120	0.006
7	Indian Creek	Indian Creek Reservoir, Connellsville, Pa.	109.6	16	4	14	63	3	1905-1937	32	6	1,560	1,550	+ 1	75	0.08	126	33	375	0.018
8	Jacob River	Upper Bridgeport Reservoir, Mt. Pleasant, Pa.	32.5	21	10	19	50	0	1887-1937	50.7	6	1,070	1,050	+ 2	70	0.10	147	65	220	0.015
9	Small Branch	Gorley's Lake, Farmington, Pa.	2.97	10	3	7	75	5	1908-1939	31	7	1,550	1,550	0	60	0.13	176	75	230	0.011
	MONONGAHELA RIVER																		
10	Tygart River	Tygart Reservoir, Grefton, West Virginia	1,182	11	1	18	65	5	1938-1945	7.0	9	1,290	1,440	- 10	50	0.05	51	75	130	0.007
	MIDDLE OHIO TRIBUTARIES																		
11	Mill Creek	Sharon Woods Reservoir, Sharonville, Ohio	4.88	58	10	21	11	0	1939-1945	5.9	9	521	492	+ 6	55	1.96	2,350	80	2,700	0.40
12	Small Branch	Ohio Pond No. 22, Marietta, Ohio	0.05	0	35	60	5	0	1938-1939	1.1	5	869	767	+ 13	40	4.00	3,485	90	3,200	0.32
13	Small Branch	Ohio Pond No. 51, Marietta, Ohio	0.13	5	0	85	10	0	1938-1939	1.1	5	869	767	+ 13	40	0.98	851	93	760	0.08
14	Small Branch	Ohio Pond No. 52, Marietta, Ohio	0.16	40	0	40	20	0	1928-1939	11	7	738	767	- 4	50	1.45	1,579	85	2,000	0.19
	MUSKINGUM RIVER																		
15	Wills Creek	Senecaville Reservoir, Senecaville, Ohio	115	35	0	50	10	5	1936-1945	8.3	12	832	768	+ 8	50	0.94	1,026	100	920	0.09
16	Small Branch	Muskingum College Reservoir, New Concord, Ohio	0.31	6	0	0	0	94	1915-1935	20	10	672	717	- 6	70	0.37	562	100	630	0.06
17	Small Branch	Experimental Watershed, Zanesville, Ohio	0.0040	100	0	0	0	0	1933-1939	6.00	15	712	702	+ 1			14,200	100	14,000	1.47
18	Small Branch	Experimental Watershed, Zanesville, Ohio	0.0056	0	0	100	0	0	1933-1939	6.00	15	712	702	+ 1			85	100	85	0.009
19	Small Branch	Tabor Lake, Lamartine, Ohio	0.54	33	5	35	27	0	1923-1938	15	7	670	672	0	50	1.38	1,510	89	1,700	0.19
20	McGuire Creek	Stoney Lake, Lamartine, Ohio	8.5	28	5	32	30	5	1927-1938	11	6	647	672	- 4	65	0.44	619	54	1,250	0.14
21	Wolf Creek	Barberton Reservoir, Barberton, Ohio	28.0	46	3	16	25	10	1926-1938	12	5	770	719	+ 7	55	1.10	1,320	85	1,410	0.14
22	Clear Fork Mohican Rive	Pleasant Hill Reservoir, Perrysville, Ohio	198	50	4	24	18	4	1938-1945	6.25	9	616	653	- 6	60	0.22	292	90	360	0.041
23	Ford Creek	Robbins Lake, Groton, Ohio	4.45	65	0	25	5	5	1922-1939	17.4	6	725	729	- 1	68	0.14	207	66	320	0.032
	KANAWHA RIVER																		
24	Little River	Radford Reservoir, Radford, Virginia	329	20	2	42	23	13	1934-1944	10.0	4	942	858	+ 10	65	0.19	269	30	780	0.06
	SCIOTO RIVER																		
25	Scioto River	O'Shaughnessy Reservoir, Columbus, Ohio	987	63	1	27	5	4	1925-1942	17	10	673	649	+ 4	65	0.13	184	62	310	0.035
	LICKING RIVER																		
26	Bank Lick Creek	Walton Reservoir, Walton, Kentucky	0.25	33	5	44	10	8	1931-1937	6	6	1,010	929	+ 9	50	4.16	4,538	98	4,100	0.33
27	Grassy Creek	Williamstown Reservoir, Williamstown, Ky.	0.47	36	3	45	10	6	1930-1937	7	8	910	929	- 2	50	2.13	2,317	96	2,500	0.20
	MIAMI RIVER																		
28	Stillwater River	Englewood Reservoir, Dayton, Ohio	639	60	5	3	27	5	1927-1942	15	10	565	592	- 5	77.5	0.04	63	30	230	0.029
29	Twin Creek	Germantown Reservoir, Germantown, Ohio	264	52	5	22	16	5	1927-1942	15	10	648	709	- 9	79.5	0.10	166	30	650	0.07
	KENTUCKY RIVER																		
30	Dix River	Herrington Lake, Harrodsburg, Kentucky	407	35	5	47	10	3	1925-1941	16.0	8	1,140	1,180	- 3	50	0.49	537	98	575	0.04
31	Small Branch	Lake Placid, Lancaster, Kentucky	0.19	54	10	30	3	3	1902-1941	38.9	8	1,260	1,260	0	50	2.62	2,860	98	2,920	0.17
32	East Hickman Creek	No. 4 Reservoir, Lexington, Kentucky	7.98	36	2	51	9	2	1913-1937	24	8	1,260	1,260	0	50	2.26	2,456	97	2,530	0.14
	LOWER OHIO AND TRIBUTARIES																		
33	Ohio River	Metropolis, Illinois	203,000	33	4	28	30	5	1943-1944	1.00	6	713	643	+ 11			170	90	160	0.018
34	Brown Creek	Loch Mary, Earlington, Kentucky	3.66	40	0	0	60	0	1888-1908	20.0	8	1,120	1,080	+ 4	60	0.60	782	97	760	0.052
	WABASH RIVER																		
35	No. Fork Vermilion River	Vermilion Lake, Danvills, Illinois	266	48	5	20	25	2	1915-1940	25.3	6	532	532	0	70	0.18	273	60	455	0.06
36	Tippecanoe River	Shafer Lake, Monticello, Indiana	1,698	47	7	15	26	5	1923-1940	17.2	4	507	532	- 5	75	0.02	38	47	100	0.014
37	Conners Branch	Greendale Lake, Xenia, Illinois	25.0	60	5	20	10	5	1927-1940	13.1	6	540	519	+ 4	70	0.14	214	50	400	0.06
38	Small Branch	Huntingburg Upper Res., Huntingburg, Ind.	0.63	20	5	45	30	0	1894-1940	46.3	8	774	774	0	40	0.62	537	96	560	0.05
39	Small Branch	Res. No. 2, Oakland City, Indiana	0.40	20	15	10	10	45	1921-1940	19.0	8	806	774	+ 4	40	1.97	1,720	100	1,600	0.15
	CUMBERLAND RIVER																		
40	Other Creek	Rednor Lake, Nashville, Tennessee	1.97	5	0	5	90	0	1915-1940	25.7	8	1,340	1,340	0	60	0.67	881	98	900	0.049
41	Little River	Lake Tandy, Hopkinsville, Kentucky	8.9	64	2	22	7	5	1907-1941	34	7	1,080	1,080	0	60	0.55	720	87	830	0.06
	GREAT LAKES BASIN																		
	LAKE ERIE																		
42	St. Mary's River	Grand Lake, Celina, Ohio	93	67	2	10	17	4	1844-1940	96	8	503	503	0	55	2.64	3,170	100	3,[illegible]	0.46
	LAKE ONTARIO																		
43	Six Mile Creek	Potter's Falls Reservoir, Ithaca, New York	44	32	10	16	35	7	1910-1941	31	10	542	653	- 2	60	0.21	273	68	[illegible]	0.05

TABLE NO.3

RECORD NUMBER	DRAINAGE BASIN & STREAM		ESTIMATED SPECIFIC WEIGHT OF SEDIMENT	MEASURED ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE		ESTIMATED PROPORTION OF SEDIMENT PRODUCTION MEASURED	ESTIMATED LONG-TERM ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE	ESTIMATED LONG-TERM SEDIMENT CONCENTRATION IN RUNOFF
			Lb/Cu.Ft.	Acre-Feet	Tons	%	Tons	% by Weight
	MINNESOTA RIVER							
44	Minnesota River	Shakopee			16	95	105	0.07
45	Minnesota River	Mendota,			12	95	80	0.05
	UPPER MISSISSIPPI AND TRIBUTARIES							
46	Bad Axe River	Victory,			506	90	520	0.07
47	Coon Creek	Stoddard			616	95	640	0.09
48	Coon Creek	Coon Val			801	95	950	0.13
49	Little LaCrosse River	Leon, Wi			633	95	740	0.10
50	LaCrosse River	West Sal			318	90	330	0.046
51	Small Branch	"UCW" Ex			33,400	100	36,000	5.01
52	Small Branch	"UPW" Ex			243	100	265	0.037
53	Beaver Creek	Lake Mar	72.5	0.17	272	100	272	0.036
54	Black River	Galesvil			162	80	450	0.05
55	Trempealeau River	Dodge, W			366	90	900	0.11
56	Buffalo River	Modena,			174	90	190	0.049
57	Buffalo River	Alma, Wi			185	90	205	0.05
58	Zumbro River	Kellogg,			2,390	95	2,520	0.64
59	Whitewater River	Weaver,			481	90	490	0.10
60	Root River	Houston,			712	90	720	0.14
61	Upper Iowa River	New Albi			940	90	950	0.19
62	Mississippi River	Wabasha,			4	50	22	0.006
63	Mississippi River	Winona,			19	50	100	0.028
64	Mississippi River	LaCrosse			25	50	125	0.033
	ST. CROIX RIVER							
65	St. Croix River	Prescott			3	10	85	0.014
	CHIPPEWA RIVER							
66	Elk Creek	Elk Cree	70	0.25	385	50	780	0.09
67	Chippewa River	Durand,			71	16	740	0.09
	WISCONSIN RIVER							
68	Wisconsin River	Lake Wis	70	0.05	72	53	150	0.016
69	Wisconsin River	Muscoda,			68	37	330	0.039
	IOWA RIVER							
70	Pine Creek	Pine Lak	60	1.52	1,990	83	2,600	0.59
71	Pine Creek	Upper Pi	60	1.14	1,490	80	1,980	0.44
72	Small Branch	Beeds La	65	0.24	340	75	450	0.10
73	Iowa River	Carolvil			452	90	335	0.07
74	Iowa River	Iowa Cit			506	90	375	0.08
	SKUNK RIVER							
75	Crow Creek	No. 3 Re	50	1.40	1,530	89	1,700	0.38
	DES MOINES RIVER							
76	Small Branch	C.M.St.P	70	0.48	769	57	1,030	0.31
77	Spring Brook	Springbr	50	0.64	698	90	860	0.28
78	Raccoon River	Van Mete			1,359	108	740	0.24
79	Middle River	Indianol			2,646	102	2,370	0.43
80	Des Moines River	Boone, I			512	110	215	0.08
81	Des Moines River	Below Ra			435	90	300	0.09
82	Des Moines River	Tracy, I			1,269	98	650	0.20
	ILLINOIS RIVER							
83	Brush Creek	Lake Bra	50	2.02	2,198	97	1,800	0.29
84	Fitch Creek	Lake Cal	60	0.96	1,256	62	1,650	0.27
85	Sangamon River	Lake Dec	51.7	0.30	341	100	310	0.043
86	Money Creek	Lake Blo	45	1.49	1,460	93	3,000	0.51
	KASKASKIA RIVER							
87	Kaskaskia River	Shelbyvi			545	95	425	0.06
	MIDDLE MISSISSIPPI AND TRIBUTARIES							
88	Middle Wolf River	No. 2 Re	40	3.54	3,090	96	2,700	0.29
89	Small Branch Bay Creek	Pittsfie	40	3.54	3,090	94	3,200	0.58
90	Bay Creek	Nebo, Il			7,240	109	3,500	0.44
91	Tilley Creek	West Fra	50	2.68	2,922	96	2,800	0.30
92	Lost Creek	Grisham	75.4	1.17	1,930	90	2,500	0.28
93	South Fork Jonaca Creek	Pineview	65	0.58	827	60	1,800	0.19
94	Meramec River	Robertsv			484	95	325	0.040
95	Big River	Byrnesvi			798	95	660	0.07
96	Bourbeuse River	Union, M			603	95	285	0.033
97	Wapsipinicon River	De Witt,			481	106	260	0.047
98	Galena River	Buncombe			2,270	105	1,470	0.25
99	Mississippi River	Clayton,			41	50	140	0.034
100	Mississippi River	Dubuque,			110	106	85	0.020
101	Mississippi River	Burlingt			161	106	120	0.024
102	Mississippi River	Keokuk R	80	0.05	229	108	290	0.06
103	Mississippi River	Hannibal			303	102	240	0.05

TABLE NO. 4

TABLE 4 - SEDIMENT RECORDS IN THE UPPER MISSISSIPPI RIVER BASIN

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
RECORD NUMBER	DRAINAGE BASIN & STREAM	POINT OF MEASUREMENT	DRAINAGE AREA	APPROXIMATE LAND USE DURING PERIOD					PERIOD OF RECORD	LENGTH OF RECORD	RELIABILITY OF RECORD	ESTIMATED AVERAGE ANNUAL RUNOFF PER SQUARE MILE		DIFFERENCE BETWEEN RUNOFF DURING PERIOD AND MEAN RUNOFF	ESTIMATED SPECIFIC WEIGHT OF SEDIMENT	MEASURED ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE		ESTIMATED PROPORTION OF SEDIMENT PRODUCTION MEASURED	ESTIMATED LONG-TERM ANNUAL SEDIMENT PRODUCTION PER SQUARE MILE	ESTIMATED LONG-TERM SEDIMENT CONCENTRATION IN RUNOFF
				Cult.	Idle	Past.	Woods	Urban				DUR. PERIOD	MEAN			Acre-Feet	Tons			
			Square Miles	%	%	%	%	%		Years		Acre-Feet	Acre-Feet	%	Lb/Cu.Ft.	Acre-Feet		%	Tons	% by Weight
	MINNESOTA RIVER																			
44	Minnesota River	Shakopee, Minnsota	15,870	33	2	21	38	6	1932-1933	1.00	6	37	110	- 66				16	95	105	0.07
45	Minnesota River	Mendota, Minnsota	16,550	33	2	21	38	6	1932-1933	1.00	6	37	110	- 66				12	95	80	0.05
	UPPER MISSISSIPPI AND TRIBUTARIES																				
46	Bad Axe River	Victory, Wisconsin	170	30	2	24	34	10	1932-1933	1.00	7	554	527	+ 5				506	90	520	0.07
47	Coon Creek	Stoddard, Wisconsin	119	18	1	23	53	5	1934-1938	4.00	11	531	523	+ 1				616	95	640	0.09
48	Coon Creek	Coon Valley, Wisconsin	77.2	33	1	26	36	4	1934-1940	6.0	9	498	523	- 5				801	95	950	0.13
49	Little LaCrosse River	Leon, Wisconsin	77.1	31	3	18	43	5	1934-1940	6.0	9	498	523	- 5				633	95	740	0.10
50	LaCrosse River	West Salem, Wisconsin	412	18	2	26	49	5	1932-1933	1.00	7	554	527	+ 5				318	90	330	0.046
51	Small Branch	"UCW" Experimental Watershed, LaCrosse, Wis.	0.0035	100	0	0	0	0	1934-1938	5.0	15	509	528	- 4				33,400	100	36,000	5.01
52	Small Branch	"UPW" Experimental Watershed, LaCrosss, Wis.	0.0041	0	0	100	0	0	1934-1938	5.0	15	509	528	- 4				243	100	265	0.037
53	Beaver Creek	Lake Marinuka, Galesville, Wisconsin	138.2	31	2	26	36	5	1867-1939	72	15	550	550	0				272	100	272	0.036
54	Black River	Galesville, Wisconsin	2,120	19	3	10	62	6	1932-1933	1.00	6	385	623	- 38	72.5	0.17		162	80	450	0.05
55	Trempealeau River	Dodge, Wisconsin	608	41	2	21	31	5	1932-1933	1.00	6	385	623	- 38				366	90	900	0.11
56	Buffalo River	Modena, Wisconsin	379	30	3	16	44	7	1932-1933	1.00	9	287	288	0				174	90	190	0.049
57	Buffalo River	Alma, Wisconsin	465	30	3	16	44	7	1932-1933	1.00	9	287	288	0				185	90	205	0.05
58	Zumbro River	Kellogg, Minnesota	1,377	61	7	16	10	6	1932-1933	1.00	9	287	288	0				2,390	95	2,520	0.64
59	Whitewater River	Weaver, Minnesota	320	58	2	16	17	7	1932-1933	1.00	7	394	368	+ 7				481	90	490	0.10
60	Root River	Rouston, Minnesota	1,280	60	2	14	17	7	1932-1933	1.00	7	394	368	+ 7				712	90	720	0.14
61	Upper Iowa River	New Alhin, Iowa	1,057	60	3	20	9	8	1932-1933	1.00	7	394	368	+ 7				940	90	950	0.19
62	Mississippi River	Wabasha, Minnesota	56,610	29	1	17	46	7	1932-1933	1.00	5	141	254	- 45				4	50	22	0.006
63	Mississippi River	Winona, Minnesota	59,245	32	1	17	43	7	1932-1933	1.00	5	148	263	- 44				19	50	100	0.028
64	Mississippi River	LaCrosse, Wisconsin	62,780	33	1	16	43	7	1932-1933	1.00	7	163	282	- 42				25	50	125	0.033
	ST. CROIX RIVER																				
65	St. Croix River	Prescott, Wisconsin	7,650	12	1	3	81	3	1932-1933	1.00	5	240	446	- 46				3	10	85	0.014
	CHIPPEWA RIVER																				
66	Elk Creek	Elk Creek Reservoir, Eau Claire, Wisconsin	60	32	1	13	49	5	1926-1941	15	6	623	629	- 1	70	0.25		385	50	780	0.09
67	Chippewa River	Durand, Wisconsin	9,010	33	2	11	47	7	1932-1933	1.00	5	383	702	- 36				71	16	740	0.09
	WISCONSIN RIVER																				
68	Wisconsin River	Laks Wisconsin, Prairie du Sac, Wisconsin	8,900	28	1	12	54	5	1914-1933	19	6	671	687	- 2	70	0.05		72	53	150	0.016
69	Wisconsin River	Muscoda, Wisconsin	10,300	34	1	12	48	5	1932-1933	1.00	5	443	622	- 29				68	37	330	0.039
	IOWA RIVER																				
70	Pine Creek	Pine Lake, Eldora, Iowa	15.24	70	0	14	7	9	1924-1932	8	11	312	325	- 4	60	1.52	1,990	83	2,600	0.59	
71	Pine Creek	Upper Pins Lake, Eldora, Iowa	13.8	70	0	14	7	9	1934-1946	13.3	9	342	327	+ 5	60	1.14	1,490	80	1,980	0.44	
72	Small Branch	Beeds Lake, Hampton, Iowa	31.6	64	1	3	30	2	1935-1946	11	11	334	329	+ 4	65	0.24	340	75	450	0.10	
73	Iowa River	Carolville, Iowa	3,035	60	5	21	9	5	1943-1946	3.00	6	418	332	+ 26			452	90	335	0.07	
74	Iowa River	Iowa City, Iowa	3,230	60	5	21	9	5	1943-1946	3.00	8	418	332	+ 26			506	90	375	0.08	
	SKUNK RIVER																				
75	Crow Creek	No. 3 Rsservoir, Fairfield, Iowa	2.92	30	5	55	10	0	1925-1934	9	7	336	333	+ 1	50	1.40	1,530	89	1,700	0.38	
	DES MOINES RIVER																				
76	Small Branch	C.M.St.P.&P. R.R. Reservoir, Madrid, Iowa	2.54	64	1	15	15	5	1903-1918	15	8	294	247	+ 19	70	0.48	769	57	1,030	0.31	
77	Spring Brook	Springbrook Lake, Guthrie Center, Iowa	2.1	51	4	11	26	8	1936-1946	10	9	217	228	- 5	50	0.64	698	90	860	0.28	
78	Raccoon River	Van Meter, Iowa	3,410	68	1	8	18	5	1940-1945	5.53	8	315	228	+ 38			1,359	108	740	0.24	
79	Middle River	Indianola, Iowa	502	63	5	22	2	8	1944-1945	1.17	8	416	404	+ 6			2,646	102	2,370	0.43	
80	Des Moines River	Boons, Iowa	5,490	60	3	25	5	7	1940-1945	5.53	8	313	197	+ 59			512	110	215	0.08	
81	Des Moines River	Below Raccoon River, Des Moines, Iowa	9,770	63	4	21	6	6	1944-1947	3.00	8	398	234	+ 70			435	90	300	0.09	
82	Des Moines River	Tracy, Iowa	12,400	66	5	16	7	6	1940-1947	7.44	6	382	238	+ 60			1,269	98	650	0.20	
	ILLINOIS RIVER																				
83	Brush Creek	Lake Bracken, Galesburg, Illinois	8.62	47	0	30	20	3	1923-1936	12.7	10	527	448	+ 17	50	2.02	2,198	97	1,800	0.29	
84	Fitch Creek	Lake Calhoun, Galve, Illinois	13.0	48	1	37	14	0	1924-1936	11.9	8	522	448	+ 16	60	0.96	1,256	62	1,650	0.27	
85	Sangamon River	Lake Decatur, Decatur, Illinois	902	65	0	28	5	2	1922-1946	24.2	13	572	532	+ 7	51.7	0.30	341	100	310	0.043	
86	Money Creek	Lake Bloomington, Bloomington, Illinois	59.2	71	7	10	7	5	1929-1941	12	6	290	424	- 31	45	1.49	1,460	93	3,000	0.51	
	KASKASKIA RIVER																				
87	Kaskaskia River	Shelbyville, Illinois	1,030	60	5	20	12	3	1942-1946	2.95	7	628	516	+ 21			545	95	425	0.06	
	MIDDLE MISSISSIPPI AND TRIBUTARIES																				
88	Middle Wolf River	No. 2 Reservoir, Rerrin, Illinois	3.03	50	0	50	0	0	1926-1935	9.3	6	783	684	+ 14	40	3.54	3,090	96	2,700	0.29	
89	Small Branch Bay Creek	Pittsfield Reservoir, Pittsfield, Illinois	1.78	63	4	28	3	2	1925-1946	21.5	11	417	407	+ 2	40	3.54	3,090	94	3,200	0.58	
90	Bay Creek	Nebo, Illinois	160	63	4	23	8	2	1942-1945	3.55	9	735	500	+ 47			7,240	109	3,500	0.44	
91	Tilley Creek	West Frankfort Res., West Frankfort, Ill.	3.54	30	5	45	20	0	1926-1936	10.0	10	725	684	+ 6	50	2.68	2,922	96	2,800	0.30	
92	Lost Creek	Grisham Lake, Bismark, Missouri	0.45	30	0	20	50	0	1930-1939	8.8	11	618	678	- 9	75.4	1.17	1,930	90	2,500	0.28	
93	South Fork Jonaca Creek	Pineview Upper Lake, Farmington, Missouri	0.48	30	0	30	40	0	1928-1938	10.0	4	583	678	- 14	65	0.58	827	60	1,800	0.19	
94	Meramec River	Robertsville, Missouri	2,673	10	0	13	75	2	1942-1946	3.64	6	792	602	+ 31			484	95	325	0.040	
95	Big River	Byrnesville, Missouri	917	30	4	15	46	5	1942-1946	3.34	7	794	678	+ 17			798	95	660	0.07	
96	Bourbeuse River	Union, Missouri	798	24	5	20	46	5	1945-1946	1.32	6	1,020	632	+ 62			603	95	285	0.033	
97	Wapsipinicon River	De Witt, Iowa	2,300	60	2	22	6	10	1942-1945	3.59	6	575	409	+ 40			481	106	260	0.047	
98	Galena River	Buncombe, Wisconsin	128	45	4	34	9	8	1942-1945	3.54	6	553	437	+ 27			2,270	105	1,470	0.25	
99	Mississippi River	Clayton, Iowa	79,200	33	1	16	43	7	1932-1933	1.00	5	221	303	- 27			41	50	140	0.034	
100	Mississippi River	Dubuque, Iowa	82,200	34	1	15	43	7	1942-1947	3.88	7	382	307	+ 24			110	106	85	0.020	
101	Mississippi River	Burlington, Iowa	115,000	38	1	16	38	7	1942-1946	3.87	7	458	368	+ 24			161	106	120	0.024	
102	Mississippi River	Keokuk Reservoir, Keokuk, Iowa	119,000	39	1	17	36	7	1913-1946	33	12	337	371	- 9	80	0.05	229	108	290	0.06	
103	Mississippi River	Hannibal, Missouri	137,000	40	2	18	33	7	1943-1946	1.98	8	472	399	+ 18			303	102	240	0.05	

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